1302. a.

THE
Country Survey-Book:
OR,
LAND-METER's
Vade-Mecum.

WHEREIN
The PRINCIPLES and *practical* RULES for *Surveying of Land*, are ſo plainly (tho' briefly) deliver'd, that any one of ordinary Parts, (underſtanding how to *add*, *ſubſtract*, *multiply*, and *divide*) may, by the Help of this ſmall *Treatiſe* alone, and a few cheap *Inſtruments* eaſy to be procur'd, *meaſure* a Parcel of Land, and with Judgment and Expedition *plot* it, and give up the Content thereof.

WITH
An *APPENDIX*, containing *twelve Problems*, touching *Compound-Intereſt* and *Annuities*; and a *Method* to *contract* the Work of *Fellowſhip* and *Alligation alternate*, very conſiderable in many Caſes.

Illuſtrated with ſeveral Copper Plates.

By *ADAM MARTINDALE*, a
Friend to Mathematical Learning.

The Eighth Edition.

London, Printed by *Hugh Meere*, for *George Sawbridge*, at the three *Golden Flower d' Luces* in *Little Britain*. 1711.

Robert Lambert
his Book

Robert
Lamb
Lambert
His Book
October the 26
1736

BRITISH MUSEUM

THE

PREFACE.

READER,

THE Title ſufficiently informs in general of my Deſigns; but I confeſs I owe a more particular Account, not only of that, but ſeveral other Things, which I ſhall briefly give thee.

1. I have obſerv'd, that the Country aboundeth with ſuch, as, by their Inclination and Intereſt, are prevail'd with to take Pains in meaſuring Land, that for want of better Inſtruction, uſe ill divided Chains, and tedious Methods of Computation, which makes their Work intolerable troubleſome, if Exactneſs be requir'd. And ſome, for want of Skill in the Fundamentals of Geometry, have imbib'd prodigiouſly falſe Principles, as this for one, *viz.* That *the Content of any Cloſe, of what Figure ſoever, may be found by ſquaring a Quarter of the Perimeter.* Mathematical-Schools, where better Things might be learn'd, are very rare; and an able Artiſt to inſtruct one in private, is hard and chargeable to be procur'd. Excellent Books indeed there are in our *Engliſh* Tongue, written by our famous *Rathborn*, *Wing*, *Leybourn*, and *Holwell*, to which may be added induſtrious Mr. *Atwel*'s Treatiſe, and ſome Part of Capt. *Sturmy*'s; but thoſe I rather eſteem fit to be read by an able Artiſt, (towards his perfecting) than by a new Beginner; for in the beſt of thoſe Books he will

find the moſt uſeful and plain Rules ſo intermix'd with others that are leſs neceſſary, and more intricate, (tho' very excellent for their proper Ends) and ſo many Curioſities touching Trigonometry, Tranſmutation of Figures, *&c.* which his Buſineſs never calls for, that for want of Judgment to pick out that which fits his preſent Purpoſe, and to ſtudy higher Speculations afterwards, he is apt to be confounded and diſcourag'd; whereby it accidentally comes to paſs, that Plenty makes him poor.

Beſides, three of theſe ſix Books are in Folio, another in Quarto, and the other two (tho' Octavo's) too large for ordinary carrying in a Pocket, and in that Regard not ſo convenient for one that hath much Occaſion to be out of his own Houſe, to ſay nothing of their Price, which, to ſome poor Youths, is not the leaſt Diſcouragement.

I have therefore made my Book ſo little, that the Price can neither much empty the Pocket, nor the Bulk over-fill it; and yet ſo plain, that I doubt not to be underſtood by very ordinary Capacities. My Method is fitted to my Deſign, beginning with the Principles of the Art, and ſo proceeding *gradatim* 'till I have ſhewn how all ordinary Figures may be meaſur'd, protracted, and caſt up, without any other Inſtrument of Charge, but Chains, Compaſſes, and Scales. Afterwards, for ſuch as deſire higher Attainments, I have endeavour'd to ſpeak ſo fully in a little Compaſs of the *plain Table*, and given ſuch Hints, applicable not only to it, but alſo to the *Peractor*, *Theodolite*, and *Semi-circle*, as that an ingenious Perſon may make great uſe of them.

But as touching the Doctrine of Triangles, and Tranſmutation of Figures into others equipollent with the large Tables (referring to the former) of Logarithms of Numbers, Signs, and Tangents, I thought it improper to cumber this ſmall Manual, or the unlearned Reader with them, having (as I humbly hope) ſufficiently inform'd him how to find all his Sides and Angles by Inſtruments, and alſo the Content of any Figure without ſuch Tranſmutation, reſerving ſuch Curioſities, and many others, touching drawing and painting of Maps, meaſuring of Ways and Rivers, *&c.* to a ſecond Part, which I may perhaps hereafter publiſh upon due Encouragement; but if I do not, the Curious may find themſelves good Store of Work in the Authors even now quoted.

2. It may ſeem ſtrange to ſome, that in referring to the Figures, I ſometimes uſe Words ſeeming to imply, that the Figure I ſpeak of is in that very Page; and ſo it was in my Copy, but the Printers and Gravers have otherwiſe contriv'd them, for Convenience in Copper Cuts, by themſelves. And to give them their Due, they are generally done with great Accuracy; and none of them having any ſuch Error as is like to beget Trouble or Miſtake to the Reader, ſaving only that *Fig.* 19. hath D inſtead of O at the Center, and the Line O L in the Margin of *Fig.* 14. ſhould be of the Length from L to the uppermoſt o in the Scale, and the Figures on the Side ſhould be made 1 leſs than they are, *viz.* 2 ſhould be 1, 3 made 2, *&c.*

Mr. *COLLINS*
TO THE
READER.

Courteous Reader,

THE learned Mr. *Adam Martindale* formerly writ two excellent Almanacks, call'd Country-Almanacks, which were printed, and eſteem'd by ſeveral Members of the *Royal Society* very uſeful, eſpecially for Country Affairs; but meeting with ſome Diſcouragements from ſuch as knew not how to judge of the Author's Worth, he gave over that Undertaking, contrary to the Deſires of many ingenious Men.

And having ſince writ a little Treatiſe of Survey, in which he hath had Experience, as well as Theory, and being willing to have the Approbation or Diſlike of others, that it might either be printed or ſtifl'd, imparted the ſame to ſome of the Members of the aforeſaid illuſtrious Body.

Upon the Peruſal of whom, and divers experienc'd Artiſts, who make a Livelihood of it, I find it well approv'd, (as clear and conciſe) only the latter were ſorry ſo much was diſcover'd, as detrimental to their Practice, particularly about ſetting off the Out-jettings, where it's inconvenient entirely to meaſure them.

The Book is ſmall, the Price (tho' not the Worth) mean, no ſmall Encouragement to young Students and the Vulgar, for whom it was chiefly intended; by which, that they may reap Benefit, is the hearty Deſire of (a Well-willer to the Author and them,)

John Collins.

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THE

Country Survey-Book:

OR,

LAND-METER's *Vade-Mecum*.

CHAP. I.

Of Geometrical Definitions, Diviſions, and Remarks.

I. A *Point* is that which hath no Parts, either of Longitude or Latitude, but is indiviſible, ordinarily expreſs'd with a ſmall Prick, like a Period at the End of a Sentence.

II. A *Line* hath Length, but no Breadth nor Depth, whoſe Limits or Extremities are Points. This is either right or crooked.

III. A *right Line* lies ſtreight, and equal between its extream Points, being the ſhorteſt Extenſion between them; the *crooked* or *circular* not ſo.

IV. A *Superficies* hath Length and Breadth, but no Depth; of this, Lines are the Limits.

V. A *plain Superficies* is that which lieth equally (or evenly) between its Lines.

VI. An *Angle* is the meeting of two Lines in one Point, ſo as not to make one ſtreight Line; and if drawn beyond that Point, they will interſect or croſs one another. This in vulgar *Engliſh* may be call'd a *Corner*; of which there be two Sorts, one *right*, the other *oblique*.

VII. A *right Angle* is that which is made by two right Lines, croſſing or touching one another perpendicularly, (or ſquarely) like an ordinary Croſs, or Carpenter's Square.

VIII. An *oblique Angle* is that which is either greater or leſs than a right Angle; and this is of two Sorts, *obtuſe* and *acute*.

IX. An *obtuſe Angle* is greater than a right Angle, like the left and right Corners of a Roman X.

X. An *acute Angle* is leſs than a right Angle, like the higheſt and loweſt Corners of the ſame Letter.

XI. A *Figure* is that which is comprehended under one Line or many; of this there are two Kinds, a *Circle* and a *right-lin'd Figure*.

XII. A *Circle* is a perfect round Figure, ſuch as is drawn with a Pair of Compaſſes, the one Foot being turn'd round in a Point, and the other wheel'd about it. The Point in the preciſe Middle is call'd the *Center*; the round Line, the *Circumference* or *Periphert*; a Line going thro' the Center, and divides the Circle into two equal Parts, is call'd the *Diameter*; half of that Line is a *Semi-diameter*, or *Radius*; half the Circle is ſtil'd a *Semi-circle*; the Quarter, a *Quadrant*; any ny Portion of it, cut off by a right Line not touching the Center, is call'd a *Segment*.

XIII. *Right-lin'd Figures* are ſuch as are limited by three right Lines, or more, and are either *Triangles* or *Triangulate*, that is, ſuch as are compounded of, and reſolvable into Triangles.

XIV. *Triangles* are Figures comprehended under three right Lines, and (as *Ramus* thinks for a Reaſon that he gives, *lib.* 6. *pr.* 6.) might be better call'd *Trilaterals*; but the Name *Triangle* from the Number of the Angles hath obtain'd.

Alſo from the Nature and Quantity of their Angles, theſe Triangles are diſtinguiſh'd into three Sorts, 1. *Rect-angl'd*, having one right Angle. 2. *Obtuſe-angl'd*, having one obtuſe Angle. And 3. *Acute-angl'd*, having all acute Angles; for no Triangle can have more right or obtuſe Angles than one, becauſe by an old Rule (eaſy to be demonſtrated) no Triangle upon a plain Superficies can conſiſt of three greater Angles than ſuch, as being jointly taken, are equal to two right.

Theſe three Sorts of Triangles may, according to the Length and Proportion of their Sides, be ſub-diſtinguiſh'd into ſeven; for each of them may have either two equal Sides or none; and the Acute-angl'd may have all three Sides or Lines equal: To all which Kinds, learned Men give diſtinct *Greek* Names, which if the *Engliſh* Reader have a Mind to ſee, they are to be found in Mr. *Wing*'s *Geodætos Practicus*, *Book* 1. *pag.* 6. For my preſent Purpoſe, the above-mention'd trimember'd Diſtinction will abundantly ſuffice; for be Triangles of what Name or Kind ſoever, they are all capable of being exactly meaſur'd by one plain Rule, as hereafter ſhall fully appear.

XV. *Triangulate Figures* are ſuch as have more Angles (and conſequently more Sides or Lines) than three; and theſe are either *Quadrangular* or *Multangular*.

XVI. *Quadrangular Figures* are ſuch as have four Angles, (and as many Sides) and theſe are either *Parallellograms* or *Trapeſia's*.

XVII. *Parallellograms* are Figures that are bounded with parallel Lines, that is, ſuch Lines as are every where of the ſame Diſtance one from another, ſo as if they were infinitely extended, they would never meet, like the upright Lines of the Roman *H*. Theſe *Parallellograms* are either *Rectangular* or *Obliquangular*.

XVIII. *Rect-angular Parallellograms* are ſuch as have four right Angles, *viz.* the *Square* or *Quadrat*, and the *long Square*, otherwiſe call'd the *Oblong*.

XIX. The *Square* is that Figure that hath four right Angles, and four equal Sides, like any of the ſix Faces of a Die.

XX. The *long Square* hath alſo four right Angles, and the oppoſite Sides are equal, but the adjoining Sides meeting at each Angle, differ in Length. Of this Figure is a well printed Page in a Book, and the Superficies of a well cut Sheet of Paper, or an ordinary Pane of Glaſs.

XXI. *Obliquangl'd Parallellograms* are ſuch as have oblique Angles, *viz.* two acute, and two obtuſe. Of theſe there are two Kinds, the *Rhombus*, and the *Rhomboides*.

XXII. The *Rhombus* is a Figure that hath equal Sides, but no right Angles, (like the Form of a Diamond on the Cards, or the moſt ordinary Cut of Glaſs in Windows) whoſe oppoſite Angles are equal.

XXIII. The *Rhomboides* is (as it were) a defective *Rhombus*; for if from any Side of a *Rhombus* we cut off a Part with a parallel Line, the Remainder will be a *Rhomboides*, which hath neither equal Sides nor Angles, but yet the oppoſite Sides and Angles are equal.

XXIV. The *Trapezium* is a Figure that is neither parallellogram, nor (conſequently) hath equal Sides or Angles, but is irregularly quadrangular, as if drawn at Adventure. Of this Shape moſt Fields prove, that ſeem to the Eye to be Squares or Oblongs.

XXV. *Multangular Figures* are ſuch as contain more Sides and Angles than four, and they are either *regular* or *irregular*.

XXVI. *Regular Multangulars* take their Names from their Number of Angles, ſo a *Pentagon*, *Hexagon*, *Heptagon*, *Octogon*, *Eucagon*, *Decagon*, ſignify multangular Figures of *five*, *ſix*, *ſeven*, *eight*, *nine*, *ten* Angles, and conſequently Sides.

XXVII. An *irregular Polygon*, or *multangular Figure*, is that which hath more Angles (and Sides) than four, the Sides (and Angles) being unequal to one another.

CHAP. II.

Of Geometrical Problems.

I. *To draw a Line parallel to another, at any Diſtance aſſign'd.*

Fig. 1. OPen your Compaſſes to the Diſtance given, and chuſing two Points conveniently diſtant in the Line given, as here at A and B, deſcribe the Arches C and D, to whoſe Convexity, if you apply a Rule, the parallel Line is eaſily drawn.

II. *To raiſe a Perpendicular upon a Line given, or to croſs that Line at right Angles in a Point aſſign'd.*

Fig. 2. Suppoſe the Point C in the Line A B were aſſign'd for the Perpendicular, open the Compaſſes to a convenient Diſtance, and mark out the two Points E and F in the Line A B, then opening them ſomewhat wider, you may (by ſetting one Foot in E and F ſeverally) deſcribe the two Arches cutting one another at the Point D, from which, if you draw a Line to the Point C, the Work is done for the raiſing of a Perpendicular; but if you be to croſs the Lines at right Angles, you may continue the Line from D thro' C at Pleaſure.

But if the ſaid Line A B had been given to be divided in the preciſe Middle, by another Line croſſing it at right Angles, the Way were to ſet one

Point of the Compaſſes in A and B ſeverally, and having deſcrib'd two Arches above the Line, interſecting one another as at D, do the like below the Line A B from the ſame Points, and with the ſame Extent of your Compaſſes, then through the ſeveral Interſections (a Rule being laid upon them) a Line may be drawn, cutting the given Line exactly in the middle at right Angles.

Note, That when one Point of your Compaſſes ſtand in A, you may make both the Arches belonging to that Center above and below the Line; and then removing the Compaſſes to B, you may croſs them both.

III. *To raiſe a Perpendicular at the End of a Line.*

Fig. 3. Let O R be the Line given, then to raiſe a Perpendicular at R, make five little equal Diviſons, and taking four of them with your Compaſſes, ſet one Foot of your Compaſſes in R, and with the other deſcribe the Arch P P; then take the Diſtance from R to 5, and placing one Foot in 3, with the other deſcribe the Arch B B, interſecting the former in the Point S; then ſhall the Line S R (being drawn by a ſtrait Rule) be a Perpendicular to the Line O R.

IV. *To let fall a Perpendicular upon a given Line from any Point aſſign'd*

Open your Compaſſes ſo as one Foot being ſet in the aſſign'd Point, the other may go clear over the Line given, and thereby deſcribe an Arch cutting the Line at two Points; then ſhall the half Diſtane

Diſtance between thoſe two Points be the Point to which the Perpendicular may be drawn from the Point aſſign'd. But if you think it too much Pains to find the Point of half Diſtance by Trial, you may help your ſelf by the ſecond Problem: For if you deſcribe two Arches interſecting one another on the farther Side of the Line from the aſſign'd Point, placing (to that purpoſe) the Foot of your Compaſſes firſt in one of the Interſections of the given Line, and then in the other; you may by laying a Rule upon the aſſign'd Point, and the Interſection of the two Arches, draw a Perpendicular from the ſaid aſſign'd Point, cutting the given Line at right Angels.

☞ *Note*, That all theſe Problems touching Perpendiculars, aim at no greater Matter, than what may be perform'd in a Mechanical way with Exactneſs enough (and much more neatly by avoiding unhandſome Pricks and Arches) by the help of a ſmall Square exactly made, (or for want thereof a Plate Quadrant, or broad Rule, having a right Angle and true Sides) for if you apply one Leg of ſuch a Square to any Line, ſo as the Angle of the Square may touch the End of the ſaid Line, or any other Point where the Perpendicular is to be rais'd, you may by the other Leg draw the Perpendicular. In like Sort to let fall a Perpendicular from a Point aſſign'd, you need only to apply one Leg of the Square to the Line, ſo as the other may touch (at the ſame Time) the aſſign'd Point, whence you may draw the Perpendicular by that Leg that toucheth the Point.

If the Angle of your Square be a little blunt, either through ill making or long uſing, you muſt allow for it when you apply it to the Point in a Line. And when you are drawing a Perpendicular, you muſt ſtop before you reach the given Line, and then by applying the Leg of your Square to that part of the Perpendicular already drawn, ſo as Part of that Leg may paſs clearly over the given Line, you may draw the reſt of your Perpendicular as exactly as if the Angle had been true. The like Courſe is to be taken when a Line is to be croſs'd by another drawn quite thro' it at right Angles.

V. *An Angle being given, to make another equal to it.*

Fig. 4. The Angle X A D being given, and a Line drawn at pleaſure, as is the loweſt from the Point E, open your Compaſſes to any convenient Diſtance, and ſetting one Foot in A, deſcribe the Arch B C. Then with the ſame Extent ſetting one Foot in E, with the other deſcribe the Arch C H, long enough to equal or exceed the other. Then taking the Diſtance B C between the Points of your Compaſſes, ſet one in C, and with the other mark the Point H in the Arch C H, through which Point H a Line being drawn from the Point E, will make an Angle with the Line E C, equal to the Angle given

☞ *Note*, When we ſpeak of the Quantity of Angles, their Equality or Unequality, we never regard the Length of the Lines; for if you extend or contract them at pleaſure, the Angle is ſtill the ſame. But that is the greateſt Angle whoſe Lines are fartheſt Diſtant from one another at the ſame Diſtance from the angular Point, or the Place where its Lines meet.

VI. *Any three Lines being given, (equal or unequal) ſo as no one of them be longer than the other two join'd together to make a Triangle of them.*

Fig. 5. The Lines A B C being given, ſet the Line A from D to E; then with your Compaſſes take the Length of the Line B, and ſetting one Foot in D, deſcribe the Arch P O. This being done, take with your Compaſſes the Length of the Line C, and ſetting one Foot in E, with the other croſs the former Arch at F, from which Interſection drawing Lines by a Rule to D and E, the Triangle is finiſh'd.

☞ *Note*, That if all the Sides, or two of them, be equal, the Method is the ſame; but the Labour leſs, becauſe we need not to take the ſame Length twice over with the Compaſſes.

VII. *To find the Perpendicular of the Triangle, in order to the Meaſuring of it.*

Fig. 6. Let the Line A B be accounted the Baſe, and from the Angle C, let fall a Perpendicular as was taught *Probl.* 4. upon that Line at D, which is ready for taking off with Compaſſes, and meaſuring on a Scale, of which hereafter in the Chapters of meaſuring the Content of Figures.

But if we have no Occaſion to draw the Perpendicular, but only to know the Length of it, (as it moſt frequently falls out in Meaſuring) no more is needful, but to ſet one Foot of the Compaſſes in the angular Point C, and extend the other to the Baſe A B, ſo as it may touch it, but not go beyond it; then have we the Perpendicular between the Points of the Compaſſes.

VIII. *One Side being given, how to make a Square.*

Fig. 7. The Line C D being given, raiſe a Perpendicular at C of the Length (at the leaſt) of the given Line; then taking the Line C D between the Feet of your Compaſſes, ſet it upon the Perpendicular from the angular Point C to A: With the ſame Diſtance ſetting one Foot in D, deſcribe the Arch O P. Laſtly, with the ſame Diſtance (or Extent) ſet one Foot in A, and with the other deſcribe the Arch, croſſing the Arch O P in N, from which Interſection a Line drawn by a Rule to A, and another to D, finiſh the Geometrical Square or Quadrant A C D N.

IX. *To make a long Square, the Length and Breadth being given.*

This is ſo like the former, that a particular Figure is not neceſſary to conceive of it. Suppoſe each Side of the Square in the laſt Problem to conſiſt of 8 ſmall equal Parts, and you were to make a long Square, whoſe Length muſt be equal to a Side thereof, *viz.* 8, and the Breadth half ſo much given in a Line thus ——— 4; then when you had drawn the Line C D, for the Length, and rais'd the Perpendicular at C, you muſt take the ſhorter Line given for the Breadth, and ſet upon the Perpendicular from C, upwards to a Point, which for Diſtinction we ſhall call the Point,

Point E, imagining it ſo mark'd: With the ſame Extent of the Compaſſes deſcribe the Arch, placing (to that purpoſe) one Foot in D. Laſtly, extending your Compaſſes to the Length of the Line C D, ſet one Foot in E, and with the other croſs the Arch aforeſaid. Then a right Line drawn from that Interſection to E, and another from the ſame to D, compleat the long Square.

X. *To make a Rhombus, the Sides being given.*

Fig. 8. If the Angles be not limited, draw any oblique Angle at pleaſure, either acute or obtuſe, as here the Angle B A C, which is acute. Then let the Line O P be the Length of a Side, which being taken with your Compaſſes, ſet it from the angular Point A, in both Lines to D and E, in which two Points, place a Foot of your Compaſſes ſucceſſively without altering them, *viz.* in D, to deſcribe the Arch F G, and in E to deſcribe the Arch H I, croſſing one another in the Point K, from which, right Lines drawn to D and E, finiſh the Rhombus D A E K.

☞ *Note,* If any Angle be given together with the Side, to limit the Shape and Content, begin with that, and proceed as before; for you muſt know, that to make a Rhombus (or Rhomboides) like to another for Figure, or equal to it in Content, it is not ſufficient to have the ſame Sides; for the more oblique the Angles are, the farther will the Rhombus differ from a Square, (and the Rhomboides from a long Square) and the leſs will be the Content. But you muſt have an Angle given, (which will produce all the reſt)

reſt) or elſe a Diagonal Line, which is a right Line paſſing through the Rhombus (or Rhomboides) from one oppoſite Angle to another, and dividing the Figure into two equal Triangles. If the former (*viz.* an Angle) be given, I have ſhew'd what Uſe is to be made of it. If the latter, (*i. e.* a Diagonal) together with the Length of the Sides, you may, by taking the Length of the Sides with your Compaſſes, and ſetting a Foot in the Ends of the diagonal Line, make a Triangle on the one Side of the Diagonal, by *Probl.* 6. and then another on the other Side by the ſame Problem, the Diagonal being a common Baſe to them both; and this will give the Figure exactly.

XI. *To make a Rhomboides, the Sides being given.*

Fig. 9. If neither Angle nor Diagonal be given, (for if either of them be limited, the Caſe is ſpoken to in the laſt Problem) make any Angle at Adventure, as here A B C. Then ſuppoſing the Lines given to be O P and Q R, ſet the Length of the longer upon the Line B C, from B to D, and the ſhorter on the Line B A to E. Then with the Compaſſes extended from B to E, ſet one Foot in D, and deſcribe the Arch F G. Likewiſe, with the Compaſſes extended to the Length of the Line O P, ſetting one Foot in E, with the other deſcribe the Arch H I, interſecting the former Arch at K; from which Interſection Lines drawn to D and E, finiſh the Rhomboides.

XII. *To make a Trapezium, the Diagonal and Lines in order being given.*

Fig. 10. Let the Line H L be the Diagonal
of a Trapezium, whoſe Sides are the Lines A B
C D; the Side A being counted the firſt, as tha
which takes it, being from the Point H, and th
reſt in the order as they are mark'd alphabetically

Then with your Compaſſes ſet to the Lengt
of the Line A, place one Foot in H, and wit
the other deſcribe the Arch E F. Next takin
the Length of the Line B, with the one Foot
your Compaſſes plac'd in L, with the other mak
the Arch G I, interſecting the former at K; fro
which Point of Interſection, Lines drawn to
and L, make the Triangle H K L.

Then with the Extent of the Line C, ſet o
of the Feet of your Compaſſes at L, and deſcri
the Arch O P. Laſtly, ſetting them to t
Length of the Line D, and placing one Foot
your Compaſſes in H, with the other make t
Arch S R, interſecting the former at Q; ſo tha
Lines drawn from Q, to L and H, make up t
Triangle L Q H, and finiſh the Trapezium H K L

I could have been much briefer in this Proble
by referring to the 6th; but this being of ve
great and frequent Uſe, I deſir'd to be very plai

XIII. *To make a regular Polygon, otherwiſe call'*
regular Multangular, or multilateral Figure, co
ſiſting of many equal Sides and Angles, viz.
bove four apiece.

Being ſatisfy'd what ſhall be the Diſtance
tween the Center and every Angle, with that
ſtance deſcribe a Circle, which being equally
vided into as many Parts as the Figure muſt h

A

Angles (or Sides, for they are equal in Number) and Lines drawn from the Points of Diviſion within the Circle from Point to Point, (ordinarily call'd Chords) the Polygon is finiſh'd as in this Diagram.

Fig. 11. Suppoſe an Heptagon, or multangular Figure of ſeven Sides, and as many Angles, be to be deſcrib'd, every Angle being deſign'd to be diſtant from the Center A, ſeven Eighths, or three Quarters and a Half of an Inch; with that Diſtance deſcribe the Circle B C D E F G H, which being divided into ſeven equal Parts, and Lines drawn from Point to Point, the Heptagon B C D E F G H will be therein included.

I ſhall rather leave my unlearned Reader to find out the Points of Diviſion by many Tryals, than to puzzle him with the Geometrical Way for finding out Chords to that Purpoſe; nor ſhall I buſy my ſelf to tell him at large how he may divide 360 by the Number of his Angles or Sides, and then finding in his Quotient the Degrees and Parts belonging to every Diviſion, ſet them readily out by a Protracter, or (for Want thereof) by a Line of Chords; for I ſuppoſe him yet ignorant of ſuch Things.

I ſhall therefore only tell him thus much: A Line drawn through the Circle at the Center, divides it into two equal Parts, which being croſs'd in the Center by another Line, the Circle will be parted into four equal Parts or Quadrants, and thoſe by halving them into eight Parts. The Extent of the Compaſſes whereby the Circle is drawn, (uſually call'd the Radius or Semi-diameter) will divide it into ſix equal Parts; two whereof muſt be a third Part, and half of one a twelfth Part; and theſe ſtill eaſily capable of farther Diviſion.

XIV. *Having the Sides of the Triangles whereof it conſiſteth, orderly given, to make an irregular Multangular, or multilateral Figure.*

This will be more fully handl'd hereafter, when I come to ſhew the Method of drawing Plats of Ground. In the Interim I will give you a Specimen of an irregular Pentagon.

Fig. 12. Having the Lines of three Triangles given, (which by a Rule hereafter to be mention'd, are neceſſary to make up a five-ſided Figure) lay down the greateſt of the firſt, *viz.* 20, from A to B for a Baſe, and by *Probl.* 6, make a Triangle of it, and the other Lines 16 and 10, *viz.* the Triangle A B O.

Secondly, You find by the Number 20 over the firſt Line of the ſecond Triangle, that it is the common Baſe to them both; and therefore, by the ſame *Probl.* 6, make the Triangle A B P of the Lines 20, 14, 18.

Laſtly, Finding the Baſe of the third Triangle to be the ſame with 18, one of the Sides of the ſecond make the Triangle P B Q of the Lines 18, 11, 12: So is the quinquangular Figure finiſh'd.

How every Line is to be found in its due order in this, or any other Sort of multangular Figures, ſo as to give a true and exact Account, not only of the ſuperficial Content, but alſo of the Figure (or Shape) and Situation, is to be taught hereafter in the Doctrine and Practice of Protraction.

CHAP.

CHAP. III.

How to find the ſuperficial Content of any Right-lin'd Figure, the Lines being given.

AS a Foundation to what I ſhall lay upon this Subject, there are ſome few Geometrical Principles or Theorems out of *Euclid* and *Ramus*, which I deſire may be remember'd ; and becauſe Underſtanding is a mighty Help to Memory, I deſign for my Country Reader a Kind of ocular Demonſtration ; which, though not ſo ſtrict and artificial as that which is to be found in the Commentators upon *Euclid* in the quoted Places, will be more ſerviceable to him, becauſe more eaſily underſtood.

Theor. 1. *Every Parallellogram being of the ſame Length with the Baſe of a Triangle, and of the ſame Height with the Perpendicular of that Triangle, is double to it.* Euclid 41. 1.

Fig. 13. Here are two equal Oblongs, or long Squares, A B C D and B E F C, and within them two Triangles inſcrib'd, whoſe Baſes are of the ſame Length, and their Perpendiculars (O P and Q R) of the ſame Height with the Oblongs. Now, each of theſe Triangles being parted into two right-angl'd Triangles by their Perpendiculars, then it is plain to the Eye (and from the Nature of Diagonals, which ever divide a Parallellogram into equal Parts) that the two new Triangles O P D and O P C, which make up the firſt of the given Triangles, are equal to the Triangles D A O and O B C, which make up the remainder of the Parallellogram A B C D. Therefore that Parallellogram is double to that Triangle which was to be demonſtrated.

In like Manner it is evident, that the Parallellogram B E F C is double to the Triangle G O F, becauſe C R Q is equal to B Q C, and Q R F is equal to Q E F.

Theor. 2. *All Triangles having the ſame Baſe, and lying between the ſame Parallels, are equal.* Euclid 37. 1.

So in our laſt Diagram, the two given Triangles having Baſes of the ſame Length, and lying between the ſame Parallels, are evidenly equal, becauſe they are demonſtrated to contain each of them the exact half of the Parallellograms, wherein they are inſcrib'd; and the Parallellograms being equal, their Halves muſt be equal alſo.

Theor. 3. *The Sides of the Triangulate (that is, one that hath four or more Sides) are ever two more than the Triangles of which it is made.* Ram. lib. 10. prop. 2.

Fig. 10, 12. This is plain by Inſpection, if you view again the Figures of the Trapezium and irregular Pentagon, in the 12th and 14th Problems of the ſecond Chapter.

Theſe Theorems being allow'd to be ſound, (as nothing more certain) the Doctrine concerning the ſuperficial Content of right-lin'd Figures, might be reduc'd to a narrow Compaſs; for he that knoweth how to huſband theſe three Theorems, may eaſily take up theſe *Corollaries, ordine inverſo.*

1. Any quadrangular Figure (regular or irregular) may by a Diagonal be parted into two Triangles; any five-ſided Figure by two Diagonals into three Triangles; and ſix-ſided Figures into four by three Diagonals, *&c.* by *Theor.* 3.

2. 'Tis no matter of what Shape the Triangle is, as to the Rule for Meaſuring, for whether it be right-angl'd, acute-angl'd, or obtuſe-angl'd, and whether it have three, two, or no Lines equal, 'tis only the Length of the Baſe, and Height of the Perpendicular, and is conſiderable by *The.* 2.

3. The true Meaſure or Content of any Triangle, whether alone, or as part of any triangulate Figure of 4, 5, 6, or more Sides, (and conſequently of the whole Figure, by ſumming up the Content of all the ſeveral Triangles) is found by *multiplying the whole Baſe* of the Triangle by *half the Perpendicular*, or the *whole Perpendicular* by *half the Baſe*; which being a Rule of ſuch infinite Uſe in Surveying, I deſire it may be remember'd; and that it may be underſtood, I ſhall give you a plain Example.

Fig. 6. Suppoſe A B the Baſe of the Triangle belonging to the 7th Problem of the foregoing Chapter, to be 44, and the Perpendicular C D to be 20: Whether you multiply 44, the whole Baſe by 10, the half of the Perpendicular, or 20, the

44	20
10	22
440	40
	40
	440

the whole Perpendicular by 22, the half Baſe, the Product gives the Content 440, as is here apparent.

Having thus given a general Method how all right-lin'd Figures may be reduc'd to Triangles, and ſo their Content found out, I might paſs to the next Head concerning Inſtruments, and their Uſe; but becauſe there are nearer Ways in meaſuring particular Kinds of triangulate Figures proper to thoſe Kinds, I ſhall briefly touch them.

I. *To find the Contents of a Square, or long Square.*

Multiply the Length by the Breadth, the Product gives the *Area* or Content.

Example of a Square.

17 Inches Length.
17 Inches Breadth.
119
17
289 Square Inches.

Example of an Oblong.

25 Feet long.
13 Feet broad.
75
25
325 Square Feet.

II. *To find the* Area *or Content in Meaſure of a Rhombus.*

Let fall a Perpendicular from one of the obtuſe Angles upon the oppoſite Side; that Side multiply'd by the Perpendicular, gives the *Area.*

20 Yards the Side.
14 Yards the Perpendicular.
80
20
80 Square Yards.

III. *To find the* Area *of a Rhomboides.*

Divide it into two Triangles by a Diagonal drawn between either Pair of the oppoſite Angles, (as ſuppoſe the acute) then from either of the other Angles (for Inſtance, the obtuſe) let fall a Perpendicular upon that Diagonal; then ſhall that Diagonal, being multiply'd by that Perpendicular, give the *Area.*

Example.

19 Rods the Diagonal.
5 Rods the Perpendicular.
95 Square Rods the Content.

IV. To

IV. *To find the Content of a Trapezium.*

Fig. 10. Divide it by a Diagonal into two Parts from Angle to Angle, as the Trapezium, *Ch.* 2. *pr.* 12. is divided by the Diagonal H L, then from the other two Angles (which in that Figure are mark'd with K and Q) let fall Perpendiculars upon the Diagonal, half the Sum of thoſe Perpendiculars being multiply'd by the Diagonal, (or common Baſe) gives the ſuperficial Content.

Example.

Suppoſe in the Trapezium before mention'd the Diagonal is 33, the Perpendicular from K 13, and that from Q 15, the *Area* or ſuperficial Content is thus computed.

13 Chains the firſt Perpendicular.
15 The ſecond Perpendicular.
28 The Sum of both Perpendiculars.
14 Their half Sum.
33 The Diagonal.

42
462 Square Chains the *Area.*

V. *To find the Content of a regular Polygonial, or multangular Figure, otherwiſe call'd multilateral.*

Draw a Line from the Center to the Middle of any Side; half of the Perimeter (or of all the

Sides) being multiply'd by that Line before-mention'd, gives the Content.

VI. *To find the Content of an irregular Polygon, or many-ſided Figure.*

Divide it into Trapezia's and Triangles by Diagonal, then find their Content ſeverally, and ſum up all together ; which that you may better apprehended,

Fig. 12. Suppoſe the Polygon belonging to the laſt Problem of the ſecond Chapter were given without the Diagonals A B and B P ; then by drawing thoſe Diagonals, the Figure is divided into three Triangles, whereof two being upon the ſame Baſe A B, make up a Trapezium, whoſe Content may be found juſt in the ſame Manner as was taught even now in the fourth Rule, having found the Perpendiculars from O and P falling upon the Line A B. Then there remains the Triangle B Q P, whoſe Content may be found by the general Rule concerning Triangles, having found the Perpendicular falling from Q on the Line B P ; and then having added the Content of that Triangle to the Content of Trapezium, you have the *Area* of the whole polygonal Figure.

☞ But now methinks I ſee (as it were) my Country Student ſcratching his Head, and wiſhing for an Opportunity to propound two Doubts to me.

1. Why I call'd the Numbers correſpondent to my Lines by divers Denominations, as Inches, Feet, Yards, Rods, and ſometimes by none at all, but propounding the Numbers abſtractly.

2. How I came to know how many of thoſe Meaſures (whatever they be) are repreſented by the Lines given, and Perpendiculars found.

To the former I anſwer, I am not yet teaching how to meaſure Lines, (that Work is preſently to follow) but what Lines of Figures are to be meaſur'd, and the Meaſures of thoſe Lines being known (or ſuppos'd) how the Content upon thoſe real (or ſuppos'd) Grounds may be found; and to this purpoſe I might call the Numbers repreſented by the Lines, Inches, Feet, Yards, or any other Meaſures at pleaſure, provided I call'd the Squares, to which the *Area* is equal by the ſame Names; for an Inch in Length bears the ſame Proportion to a ſquare Inch (having Length and Breadth) that a Mile in Length bears to a ſquare Mile. For this Reaſon I profeſs not in the Title of this Chapter to teach how to meaſure Figures, much leſs how to meaſure the Lines of ſuch Figures, but how to find the Content, the Lines being given.

And then to take away the ſecond Doubt, know that the Numbers repreſented by the Lines, were either given by thoſe learn'd Artiſts from whom I borrow'd the Figures, or ſuppos'd by my ſelf as Grounds to go upon (as in ſuch Caſes is ordinary) or laſtly, found out to be agreeable thereto by ſome Scale of ſmall equal Parts, which he is yet ſuppos'd ignorant of. But now I am going to ſhew him the Nature and Uſe of two or three plain and cheap Inſtruments, by the Help whereof he may with much Exactneſs, 1. Meaſure the Length of any Lines bounding right-lin'd Figures upon the Ground. 2. Draw Lines and Figures upon

Paper proportionable thereunto (which we call protracting.) 3. Find upon his Paper-figures the true Length of all the deſir'd Perpendiculars, which ſhall alſo be proportionable to thoſe on the Ground, but much more eaſy to be obtain'd. And withal, I intend to give him ſuch farther Inſtructions and Cautions, for the Application for the general and more particular Rules of this Chapter to his peculiar Uſe, as will render them (eſpecially ſome of them) ſingularly adventageous.

CHAP. IV.

Concerning Chains, Compaſſes, and Scales.

I. AMongſt the many ſorts of *Chains* us'd for meaſuring Land, three are moſt famous, bearing the Names of their Inventors, Mr. *Rathborne*, Mr. *Gunter*, and Mr. *Wing*, all of them ingeniouſly divided, and uſeful in their Kind; but my Brevity will give me leave only to deſcribe one, and that ſhall be Mr. *Gunter*'s, being moſt in Uſe, and eaſy to be procur'd.

This Chain contains in Length, four Statute-Poles or Perches, each Perch containing 16 Feet and a half, or 5 Yards and a half; ſo that the whole Chain is 66 Feet, or 22 Yards long.

This whole Chain is divided into 100 equal Parts or Links, whereof 25 are a juſt Pole or Perch; and for ready counting, there is uſually a remarkable Diſtinction by ſome Plate or large Ring at the end of every 25 Links, but eſpecially at the preciſe

Middle of the Chain, which ſhould differ from the reſt in Greatneſs and Conſpicuouſneſs. Alſo at the end of every tenth Link, 'tis uſual to hang a ſmall Curtain-Ring; and if there be at every five Links end a piece of Wyre made like the Bow of a Link, with a little Shank an Inch or leſs long, (or ſome ſuch Diſtinction) 'tis ſtill better.

When you are to meaſure any Line by this Chain, you need to regard no other Denomination but only Chains and Links, ſet down with a Prick of your Pen betwixt them. *e. g.* If you found the ſide of a Cloſe to be 6 Chains and 35 Links long, it is thus to be put down, 6. 35.

But if the Links be under 10, a Cypher muſt be perfix'd; ſo 7 Chains 9 Links muſt be thus ſet, 7. 9.

In the uſing of this (or indeed of any) Chain, care muſt be taken both to go ſtrait, and to keep a true Account; for which Purpoſe, it is good that he which goeth before, carry in his Hand a Bundle of Rods, to ſtick down one at the end of the Chain which leads, having firſt ſtretch'd it well, and that he which follows do not only gather up the Rods to keep the Account, but alſo at every Remove, mark whether he ſee the Leader directly between his Eye and the Angle, or other Mark he aims to meaſure to; and if need be, call to the Leader to move towards the right or left Hand, 'till he ſee him in a direct Line to it.

II. *Compaſſes* are ſo well known, that I need not deſcribe them; only they ſhould be of Braſs, with Steel Points, ſmall and neatly wrought, nine or ten Inches long from the Joint to the Points, turning ſo truly upon the Rivet, that they may be eaſily open'd, and yet ſtand ſo firmly, that an Arch or Circle may be, without their ſhrinking, deſcrib'd upon a large *Radius*.

For the Form, I will commend, above all, thoſe that have large Bows, ſo contriv'd that by preſſing them with the hinder part of the Hand, they will gently open, and by the Thum and fourth Finger be put together, (as others will) ſo that they are manageable by one Hand, which is a great Convenience for one that at the ſame Time ſhould hold his Rule with Scales in the other.

Theſe might alſo be contriv'd with a Screw to take out one of the Points, to place in the room (upon Occaſion) a Black-Lead Pen, or any other Pen to draw Circles with, either black or otherwiſe colour'd,

And for a Man that would be an Artiſt indeed, it were convenient he were furniſh'd with dividing Compaſſes, Beam Compaſſes, and Triangular ones, for ſeveral Uſes not here to be mention'd; but a Country Surveyor may make a good Shift with ſuch a plain Pair as I firſt deſcrib'd, which Mr. *Wynne*, over againſt the *Rolls* in *Chancery-lane*, will help him to, with the Chain and Scales, for a ſmall Matter.

III. *Scales* are certain Lines divided into equal Parts, upon Plates or broad Rules of Braſe or Box, and they are of two Sorts, 1. Plain. 2. Diagonal.

1. *Plain Scales* are made up of two ſmall Lines parallel to one another at a little Diſtance, and theſe are divided into great equal Parts, which

ſignify Tens, and are noted 10, 20, 30, 40, 50, *&c.* according to the Length of the Lines.

They may be of any covenient Length, but theſe great Diviſions are ſeldom more than Inches, or leſs than third Parts apiece.

Again, one of the great Diviſions (or Parts) is ſub-divided into ten equal Parts by ſhort Lines, whereof that in the Middle ſtanding for 5, is longer than the reſt.

Fig. 13. According to the Numbers of theſe little Parts contain'd in an Inch, the Scale is nam'd *A Scale of* 10, 11, 12, 16, 20, 24, 30, &c. *in an Inch.* That ſhort one which I give you the Figure of A, is of 10 in an Inch, ſo noted at the Top, according as is uſual upon Rules, and Indices of plain Tables. The Line mark'd O Q, ſeparates Unites and Tens; Unites being taken upward from that Line, and Tens downward; mixt Numbers both ways.

As for Example.

7 is the Extent of the Compaſſes upon the Scale A, from the Line O Q to K; 30 is their Extent from the Line ſo mark'd to O Q; and 27 is their Extent from the Line 20, to the ſhort Line K aforeſaid.

Here note, that you muſt not expect to find the Letters O Q or K upon the Scales which you buy, being only Marks us'd at Pleaſure, to make my Meaning plain; and likewiſe that this Scale of 10 in an Inch, and others that are ſmaller, (all being compos'd after the ſame Manner) are uſually made, for more convenient Uſe, ſo long as to contain nine or ten (the more the better) of the great Diviſions, ſignifying Tens; though the Figure at A being deſign'd for no other Uſe than to help our Conceptions, extends but a little beyond 30, that Length being ſufficient for my Purpoſe in this Place.

Fig. 14. Theſe plain Scales, eſpecially the ſmaller Sorts of them, (ſuch as 24 or 30 in an Inch) are very proper for drawing Figures upon Paper, where the Numbers repreſented by the Lines are not above 100, (for then every Diviſion may be counted as it is upon the Scale) or above upon a long Scale.

Alſo in the ſurveying of Foreſts, Chaſes, and great Commons, where the Lines are vaſtly long, and the Miſtake of a few Lines (yea, of half a Pole) is not conſiderable, they may be conveniently us'd, accounting the Tens and Unites to ſignify ſo many whole Chains, and ſo eſtimating the Parts of a Chain with the Compaſſes upon the ſmall Diviſions, which a ſagacious Man may do very near upon one of the larger Scales. But it were much better, in my Opinion, for ordinary Meaſuring, if the grand Diviſions on the Scale were two Inches apiece, (as I have one upon the Index of my plain Table) for then the ſmaller Diviſions being of five in an Inch, would be ſo large as to be ſub-divided into five apiece, which repreſents 20 Links; and then the Half one of thoſe ſmaller Diviſions ſignifying 10 Links, and the Quarter 5, a very ordinary Judgment may come very near to the Truth by Eſtimation.

2. But the *Diagonal Scale* is ſo well known to every Mathematical-Inſtrument-maker, ſo eaſy

to be procur'd, and every way ſo fitted to *Gunter*'s Chain and your Country-man's Uſe, that I cannot but highly commend it.

Of theſe Diagonal Scales, there are two Sorts, the Old and the New.

Fig. 14. By the Old one, I mean ſuch as is to be found in Mr. *Leybourn*'s Book, whereof I ſhall preſent you with a Fragment, with ſuch a Deſcription as may enable you to underſtand the Whole.

1. It is made (as appears by the Figure B) upon eleven parallel Lines equidiſtant, ſo as to include ten equal Spaces, which are all cut at right Angles by tranſverſe Lines dividing them all into four equal Parts.

2. One of theſe tranſverſe Lines, (*viz.* P R) where it toucheth the firſt and laſt Lines, ſeparates between the Hundreds (or whole Chains) and the Tens, (repreſenting 10 Links apiece) the Chains being number'd downwards on the left Hand from P only to 3, but on the Inſtrument it ſelf they may go on to 9 or 10, (the Rule being a Foot long) but the Tens (or Decads) upward from P to 10.

3. From the Points of Diviſions into Tens upon the firſt Line, beginning at P, to the like Points beginning at R in the laſt Line, are nine Diagonal Lines drawn, the firſt beginning at P, and ending at the firſt Diviſion above R. The ſecond beginning at the firſt Diviſion above P, and ending at the ſecond above R. In a Word, they are all drawn from one Diviſion leſs from P, to one more from R; by which it comes to paſs that every Diagonal, by that Time it hath paſs'd from the firſt Line to the eleventh, is a whole

tenth Part of an Inch (which anſwers to ten Links of the Chain), farther diſtant from the Line P R, than at the Point upon the firſt Line whence it was drawn.

4. Every one of thoſe Diagonals is divided into ten equal Parts by the long parallel Lines running through the whole Scale, and number'd on the Top from 1 to 9. Whereby it is evident, that the Interſection of any of the nine parallel Lines that are number'd at the Head with any Diagonal, muſt be farther diſtant from the Line P R, than the Interſection of the Line next before it with the ſame Diagonal by $\frac{1}{10}$ of $\frac{1}{10}$, that is, by $\frac{1}{100}$, which anſwereth to a ſingle Link of your Chain.

From what hath been ſaid, and Inſpection of the Figure B, theſe Things plainly follow; which, as ſo many clear Inſtances, will help you to underſtand it fully.

1. The Diſtance from P R, to the ſecond Diviſion below it, anſwereth to two Chains.

2. The Diſtance from P R to the eighth Diviſion upward, being taken (with Compaſſes) upon the firſt Line of the eleven from P to 8, anſwereth to 80 Links.

3. Conſequently the Extent of the Compaſſes from the ſecond grand Diviſion below P, to the eighth of the leſs Diviſions upward, is proportionable to 2 Chains 80 Links.

4. The Diſtance from P R to the firſt Diagonal being taken upon the parallel Line, noted with 9 above, anſwereth to 9 Links: Where note, that the firſt Diagonal is not that which is

noted with 1, but that which is drawn from the Point P.

5. The Diſtance upon the ſame Line from P R to the Diagonal that is mark'd with 7, is anſwerable to 79 Links.

6. The Extent of the Compaſſes from the Bottom of the Figure upon the ſame Line to the ſame Diagonal, anſwereth to 3 Chains 79 Links.

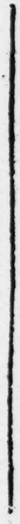
Briefly whole Chains may (by Analogy) be meaſur'd upon any Line from P R, to the grand Diviſion noted with the given Number, Decads alone, or Chains and Decads upon the firſt Line of the eleven where the Diagonals begin. Links alone, Decads with Links, and Chains and Decads with Links, always upon that Line upon which the Number of the odd Links ſtands at the Head of the Scale.

☞ And know, that theſe Directions *(mutatis mutandis)* will as well fit, if half an Inch be only allow'd for a Chain, and conſequently all the Diagonals drawn within that Extent, as it is uſual (and very commodious for longer Lines) upon the other End of the ſame Rule, the grand Diviſion for Chains going the contrary Way, and noted with numeral Figures in order. It is good therefore when you furniſh your ſelf with Scales, to have diagonal Scales of both Dimenſion on the Fore-ſide of your Rule, and upon the Back-ſide many plain Scales of equal Parts, with a Line of Chords; all which you may have (by enquiring only for the Scales deſcrib'd in Mr. *Leybourn*'s Book) of Mr. *Wynne* aforeſaid, as likewiſe all other mathematical Inſtruments.

Having been ſo large for my plain Countryman's Sake, I ſhall not proceed to the Deſcription of the new diagonal Scale, of which you may have the Figure and Deſcription in Mr. *Wing*'s Book; for though it be an excellent good one, as I know by Experience, Mr. *Hayes* having (at my Deſire) furniſh'd my noble Friend Sir *Charles Houghton* with an artificial one of that Sort, when I had the Honour of aſſiſting him in mathematical Studies; yet becauſe 'tis pretty coſtly, if well made, and that before deſcrib'd will very well anſwer its End, I ſhall at preſent ſay no more of it.

But my Reader may perhaps object to me, that though I have inſtructed him how he may make a Line of an exact Length, to anſwer to any Number of Chains and Links (given or found by Meaſure) upon the diagonal Scales; I have not yet ſhew'd him how to meaſure a Line (as ſuppoſe a Perpendicular) whoſe Length is unknown upon them.

To give him therefore all Satisfaction, (tho' what I have writ already might help him to find this out) let us ſuppoſe, that in ſome Figure made according to the diagonal Scale B of 100 in an Inch, we meet with meaſuring in an unknown Perpendicular, equal to the Line in the Margin. Taking it between the Points of my Compaſſes, I firſt try whether it be even Chains, and finding upon the firſt View that it is not, I make a ſecond Tryal, whether it will prove to be even Decads, or ten of Links; to which Purpoſe I ſet one Foot at 3 Chains in the Bottom of my Scale in the firſt Line where the



Diagonals begin, and the other Foot reſts in the ſame Line betwixt 6 and 7; whereby I am aſſur'd the odd Links above 3 Chains are more than 60, and leſs than 70. And to find how many above 60, I remove the Compaſſes from Parallel to Parallel in order, 'till one Foot in the loweſt Line reſting in the End of a Parallel, the other will touch ſome Diagonal at the Interſection with that Line, which falls out to be at L and O in the Line mark'd with 7, ſhewing the whole Line, being meaſur'd by that Scale, to ſignify 3 Chains and 67 Links.

CHAP. V.

How to caſt up the Content of a Figure, the Lines being given in Chains and Links.

HAving deſcrib'd theſe plain Inſtruments, and in ſome Meaſure ſhew'd the Uſe of them ir Severals, it were very proper in the next Plac to teach their joint Uſe in meaſuring and protracting; but becauſe I would have my young Surveyor, before I take him into a Cloſet, able t perform his whole Work together, I intend t ſhew him, 1. How he ought to make his Computations; 2. The Grounds or Principles tha will juſtify him in ſo doing.

For the firſt, take theſe Rules:

1. Put down your Length and Breadth c Squares and Oblongs, and your Baſe and half Perpendicular of Triangles directly under one anothe

e

expreſs'd by Chains and Links with a Prick betwixt them, as was taught before, *Chap.* 4.

2. If the odd Links were under ten, put a Cypher before the numeral Figure expreſſing them, (as there alſo was ſhew'd) and if there be no odd Links, but all even Chains, put two Cyphers after the Prick.

3. Multiply Length by Breadth, and Baſe by the half Perpendicular, according to the Rules for finding the Content of Figures, *Chap.* 3.

4. From their Product cut off 5 Figures (accounting Cyphers for ſuch) reckon'd from the right Hand backward, with a Daſh of your Pen, ſo ſhall thoſe to the left Hand ſignify Acres.

5. If thoſe five cut off were not all Cyphers, multiply 'em by 4, and cutting off five toward the right Hand again, the reſt will be Roods or Quarters.

6. If amongſt theſe five Figures toward the right Hand that were cut of at the ſecond Multiplication, there be any Figures beſides Cyphers, multiply all the five by 40, and cutting of five again by a Daſh of your Pen, thoſe on the left Hand ſignify ſquare Perches, Poles, or Roods.

A few Examples will make all plain.

Queſt. 1. *What is the Content of a Square, whoſe Sides are every one of them 7 Chains, 25 Links?*

Length 7. 25.
Breadth 7. 25.

3625
1450
5075

5|25625

5|25625

5|25625
4
1|02500
40
1|00000

Anſw. 5 Acres, 1 Rood, and 1 Perch, as here appears.

Queſt. 2. *In a long Square whoſe Length is 14 Chains, and the Breadth 6 Chains 5 Links, what is contain'd ?*

Length 14.00
Breadth 6.05

7000
84000

8|47000
4
1|88000
40
35|20008

Anſw: 8 Acres, 1 Rood, and 35 Perches, as the Work makes it evident.

Queſt 3. *In a Triangle, whoſe Baſe is 3 Chains, and half the Perpendicular 98 Links, what is the Content?*

```
The Baſe        3.00
Half Perpend.   0.98
               -----
                2400
               2700
              ------
              |29400
                   4
              ------
             1|17600
                  40
              ------
             7|04000
```

Anſw. 0 Acres, 1 Rood, 7 Perches, as here is plain.

There be no other Ways of Computation by Scales, Tables, &c. But that this is ſound and demonſtrative, I come now to ſhew by theſe following Steps.

1. It is evident, that in this Way of Multiplication, the Product is ſquare Links; for every Chain being 100 Links, it is all one to multiply 7.25 by 7.25, or 725 by 725 without Pricks; for the Pricks ſignify ſomething as to Conceptions, but nothing at all in Operation. The Product therefore of the firſt Example was really 525625, Links.

2. Every Chain being 4 Perches long, it follows, that 5 Chains (or 20 Perches) in Length, and 2 Chains (or 8 Perches) in Breadth, make an Acre, or 160 ſquare Perches; for 20 being multiply'd by 8, gives 160.

3. From hence it plainly followeth farther, that there are exactly 100000 ſquare Links in an Acre; for 5 Chains multiply'd by 2, is the ſame with 500 Links by 200, which makes 100000. And he deſerveth not the Name of an *Arithmetician*, that is ignorant of this old plain Rule, *When the Deviſor conſiſts of* 1 *and Cyphers, (as* 10, 100, 1000, 10000, 100000, &c.*) cut off from the right Hand ſo many Figures of the Dividend as the Deviſor hath Cyphers, accounting them the Remain; ſo ſhall the reſt on the left Side be the Quotient.* It is plain then that 525625 ſquare Links, make 5 Acres, and 25625 ſquare Links over.

Thus I have made clear to a very ordinary Capacity, that as far as concern Acres, the Rules for Computation are good. Now, for Roods and Perches, tho' I might turn off my Reader with that known Rule in decimal Arithmetick, *Multiplying decimal Fractions by known Parts, gives thoſe known Parts in Integers, due Regard being had to the Separation*, I ſhall proceed in my plain Way thus: If 25625 ſquare Links, which remain above an Acre, do contain any Quarter or Quarters of an Acre, then, if they be multiply'd by 4, and divided by 100000, (that is, five cut off from the Product) they will contain ſo many Acres as now they do Quarters (or Roods,) for any Number of Quarters multiply'd by 4, muſt needs produce the like Number of Unites or Integers, and the Diviſion doth only reduce them into the right Denomination. Now, 25625 being multiply'd by 4, and five Figures being cut off from the Product, the Reſult is, 1|02500, that is, an Acre and above; which ſhews it was above a Quarter before it was multiply'd by 4.

And to find how much, (that is, how many ſquare Perches are contain'd in this laſt Remainder) you muſt conſider this 2500, not as ſquare Links remaining above the Rood or Quarter, but as fourth Parts or Quarters of ſquare Links, or (which is all one) as the true Number of ſquare Links multiply'd by 4, and conſequently being multiply'd by 40, (the fourth Part of ſquare Perches in an Acre) it muſt as often contain 100000 ſquare Links (or an Acre) as the Quarter of this Number 2500, *viz.* 625, ſignifying ſquare Links, containing ſquare Perches; and ſo it doth, for 100000 divided by 160, (the Number of Perches in an Acre) gives 625, as anſwereth to 1 Perch; and 2500 multiply'd by 40, gives 100000, or 1 Acre, the five Cyphers being cut off, as here is manifeſt.

```
  2500          160    100 000625
    40                 960
-------                ---
1|00000                400
-------                320
                       ---
                        800
                        800
                        ---
                          0
```

Some may perhaps wonder, that in ſo ſmall a Manual I ſpend ſo many Words about ſuch ordinary Things as in this and the laſt Chapter; but I am moſt afraid, leſt I ſhall not for all my Plainneſs be ſufficiently underſtood by ſuch as I purpoſely write for, in Things of ſuch neceſſary and frequent Uſe: And I deſign'd not to make this Treatiſe ſmall, by being obſcurely brief in ſubſtantial Things, but by leaving out ſuch Curioſities as I thought my Country Friend might well ſpare.

CHAP. VI.

How to meaſure a Cloſe, or Parcel of Land, and to protract it, and give up the Content.

HItherto we have been like Children learning to ſpell, now let us ſet our Syllables together; I mean, let us make Uſe of the Inſtructions before-going to meaſure a Piece of Land, to plot it, and to caſt up the Content.

All Cloſes, or Parcels of Land, are either ſuch as need not to be plotted for finding out their true Meaſure, but the Chain alone doth the Work; or ſuch as cannot be conveniently meaſur'd without Plotting or Protraction.

Of the firſt Sort are the Square and long Square, known before-hand to be ſuch, or found ſo to be by ſuch Inſtruments as I have not yet deſcrib'd, or by meaſuring all the Sides and Diagonals. Theſe Squares and long Squares, I ſay, need no protracting; for you need only to multiply the Chains and Links of the Length, by the Chains and Links of the Breadth, and ſo proceed as in the firſt and ſecond Examples of the fifth Chapter:

ter: But all others, whether Triangles or Triangulate, are to be protracted. I ſhall give Examples therefore in the three ſorts of Figures, Triangular, Quadrangular, and Multangular.

But before I proceed to particular Inſtances, let me adviſe the young Practitioner thus: Remember,

1. To begin at ſome notable Angle of the Field, where there is ſome Houſe, Gate, Stile, Well, or the like; or if there be none, then to dig up a Clod, drive down a Stake, or at leaſt, to obſerve what quarter of the Heavens it pointeth towards, whether Eaſt, Weſt, North, or South, and on your Paper mark it with the Letter A, or any other.

2. To go parallel to the Side of the Field, if Pits, Buſhes, or the like, hinder not, (and if they do, to allow for it) accuſtoming your ſelf to go either *cum Sole*, that is, with your left Hand towards the Hedges, Walls, or Pales; or *contra Solem*, with your right Hand towards them; and when you go contrary to your uſual Cuſtom, note it on your Paper by ſome Mark known to your ſelf.

3. To ſet down the Chains and Links of every Side as you meaſure them, and not truſt your Memory. A Black Lead Pen will be very proper for this Purpoſe.

4. To take heed (if you have more Scales than one upon your Rule) leſt you confound your ſelf by taking Lines off of ſeveral Scales, or meaſuring Perpendiculars upon wrong ones; for every Line of the ſame Figure muſt be made by the ſame Scale, and the Perpendiculars meaſur'd by it.

5. To make Uſe of a Scale of larger Diviſions when you meaſure ſmall Cloſes, and of ſmaller when you meaſure great ones.

6. To make your Lines and Points where Angles meet, ſmall, pure, and neat.

7. To ſet on your Chains and Links at twice, when any Line is too long for your Scale.

Theſe things being premis'd, I proceed thus:

I. Suppoſe I meaſure a triangular Field with my Chain, beginning at Eaſtern Angle A, and find the Sides in their Order and Meaſure to be ſeverally thus; (I going *cum Sole)* 2.229, 3.45, 4.07.

Making uſe of the leſs diagonal Scale, becauſe the other would make the Figure too large, (otherwiſe it were more proper for ſo ſmall a Cloſe) I firſt with my Compaſſes take off the Scale 4 Chains and 7 Links, and ſetting them from A to C, draw that Line for the Baſe, becauſe the longeſt of the three; then I take 2 Chains 29 Links off the ſame Scale, and ſet them in the Eaſtern Point A, where I began, and turning the looſe Foot of the Compaſſes above the Line A C, becauſe I went *cum Sole*, I deſcribe (at that Diſtance 2.29.) the Arch E E.

Next taking with my Compaſſes upon the ſame Scale the Extent of 3 Chains 45 Links, I place one Foot in the Point C, and with the other make the Arch F F, interſecting the former in the Point B; and drawing the Lines A B and BC, (as was taught in *Ch.* 2. *Probl.* 6.) the Triangle A B C is the Plot of the triangular Field meaſur'd.

But before I can give the Content, I muſt find the Length of the Perpendicular, which is done by ſetting one Foot of the Compaſſes in B, and extending the other to the Baſe A C, ſo as it touch it, and paſs not over it, (according to *Ch.* 2. *Probl.* 7.) for then the Length of the Perpendicular is between the Points of the Compaſſes, and being apply'd to the ſame Scale by which the Triangle A B C was made, it appears to be 1 Chain 42 Links. With the half whereof I multiply 4.07, the Length of the Baſe, and proceeding in my Work as was ſhew'd in the laſt Chapter, the Content appears to be 0 Acres, 1 Rod 6 Perches, as it is here evident.

The Baſe	4.07	4.07
Half Perpend.	0.71	0.71
	407	407
	2849	2849
	128897	28897
	4	4
	1|15588	115588
	40	40
	6|23520	623520

II. Suppoſe I were to meaſure a quadrangular or four-corner'd Field, I begin as before at ſome remarkable Angle; and going round the Cloſe, *cum Sole*, I find the Sides to be 9.04, 6.72, 8.46, 7.28, and the Diagonal from that remarkable Angle to the oppoſite Angle to be 10.02, I begin therefore to protract it thus:

Fig. 16. Having by the Help of my Scale and Compaſſes drawn my Diagonal 10.02 from my remarkable Angle A to C, the oppoſite Angle, I make a Triangle of it, and the firſt and ſecond Sides 9.04 and 6.72, according to *Ch.* 2. *Probl.* 6. and another after the ſame Method of that Diagonal, and the third and fourth Sides 8.46 and 7.28, ſo have I the Trapezium A B C D.

Then by the Help of my Scale and Compaſſes, I find the Perpendicular of the Triangle A B C to be 6.02, and of the other, *viz.* C D A 6.01, which added, are 12.03, whereof the half Sum is 6.01; by which, multiplying the Baſe 10.02 and proceeding as formerly hath been ſhewn, I find the Content of the Field to be 6 Acres, 0 Roods, 3 Perches, as is here apparent.

The Baſe	10.02
Half Perpend.	6.01
	1002
	60120
	6|02202
	4
	|08808
	40
	3|52320

Before I paſs any farther, let me tell you,

1. Any quadrangular Cloſe, or parcel of Ground whatſoever, having right Lines, may be thus meaſur'd, protracted, and computed.

2. The odd Meaſure above Perches, is not valuable here, nor in the former Computations, being always under a ſquare Perch ; but in Multangulars, where there be many Remainders, they muſt be ſumm'd up, and the Perches contain'd in them added to the Content before found.

3. This laſt, and the following Figures, (where I uſe any Scale at all) are made, that they might not be too large, by a Scale of 400 in an Inch, *i. e.* by the leſs Diagonal Scale, each Chain and Link being counted two.

III. *Fig.* 17. If this multangular Figure be conceiv'd to repreſent a Cloſe of ſeven Sides, which is to be meaſur'd, I begin at the remarkable Angle A, and going round the Cloſe, (with the Sun) I find the Sides to be in Meaſure 3.11, .49, 2.47, 1.77, 4.11, 2.29, 4.37.

Then I meaſure the four Diagonals, B D, D F, F B, and B G, in the order that I nam'd them, and I find them to be 3.45, 4.97, 4.13, and 4.36, which is as ſhort a Way as can be taken, to prevent unneceſſary Walks.

But when I come to protract by the Help of my Scale and Compaſſes, I firſt make the Triangle B C D of the firſt Diagonal, and the ſecond and third Sides. Then the Triangle D E F upon the ſecond Diagonal, and fourth and fifth Sides ; and upon the ſame Diagonal, as a common Baſe, the Triangle B D F of the firſt, ſecond, and third Diagonals.

Next of the ſame third Diagonal, together with the 4th and 6th Sides, I make the Triangle B F G, and upon the fourth Diagonal, as upon a common

Baſe with the firſt and laſt Sides, the Triangle A B G. So is the whole Cloſe plotted.

And now it ſtands viſibly reduc'd into two Trapezio's ABFG and BDEF, together with the Triangle BCD, which I ſhall not now caſt up, having ſo often ſhewn how ſuch Work is to be done.

But I muſt acknowledge that this ſort of Plotting of parcels of Land that have many Angles, requires not only more Care and Pains, but better Skill and Memory, than to draw Diagonals upon Paper, when the Plot is already taken by the plain Table, or other ſtanding Inſtrument. I ſhall therefore, to help my young Practitioner in this Caſe, and advertiſe him of two eaſy Ways to help himſelf, ſo as to be out of Danger of Miſtakes.

One Way is, to divide the multangular Field into two or more Parts, as the laſt might have been by the Diagonal B F; then might each Part have been meaſur'd ſeverally, as if they had been ſeparated by a Pale, or were ſundry Mens Lands parted by a Boundary.

Another Way that much helps both the Underſtanding and Memory, is, to draw a rude Draught of the Figure of the Land you intend to meaſure, not only as to the Sides, but alſo neceſſary Diagonals. Then meaſuring the Lines upon the Ground correſpondent to thoſe on the Paper, (which by the Help of the Draught may be eaſily hit) ſet the Lines as you meaſure them upon the Lines of the Draught, as if it were the true ones, and when you have finiſh'd your Meaſuring, protract it truly. Such as you ſee here (but it's better larger) will do your Buſineſs, for 'tis not a Pin Matter how rude or falſe the Lines or Angles be, Reſemblance being all that is deſir'd.

CHAP. VII.

Concerning the meaſuring of Circles, and their Parts.

I Have hitherto abſtain'd of purpoſe from meddling with the Circle, and its Parts, that I might lay thoſe Things cloſe together without unneceſſary Mixtures, that are of greateſt Uſe.

'Tis wonderful rare, if a Land-meeter ever have Occaſion to meaſure any Field or Parcel of Land, that will prove either Circle, Semi-circle, Quadrant, or Sector. Sometimes indeed there will be a little Crook in an old Hedge bowing like an Arch; but I have never ſeen any Offer to meaſure it as a Segment, but always take it as an Angle or Angles.

Yet becauſe it may be expected I ſhould ſay ſomewhat of thoſe Things, I ſhall briefly do it.

I. To meaſure a Circle in the more exact Way, is, to ſquare the Diameter, and to multiply that Square by 7854; ſo ſhall the Content be in Integers and Decimals.

But the more uſual and quick Way, (and near enough for any Uſe we ſhall make of it) is, to multiply the half of the Periphery or Circumference by the Semi-diameter.

In like Manner to find the Content of a Semicircle, Quadrant, or Sector, made up of Semi-diameters,

meters, and arch'd Lines, multiplying the hal Arch by the Semi-diameter, gives the Content.

Fig. 19. But that which falls out moſt frequently in Menſuration, (tho' ſeldom much regarded, ſave where a curious Exactneſs is requir'd) is that particular Sort of Segment which we call a *Section*, leſs than a Semi-circle, ſuch as this Figure A B C. And to find the Content of it, the Center of th Circle, whereof this is a Section muſt be firſt found out, as here at O, from which Lines drawn to A and B, make up the Sector AOBC; which being meaſur'd according to the laſt Rule, and from the Content thereof, the Content of the Triangle A O B ſubſtracted, the Difference or Reſidue is the Content of the Section A B C.

But two Queſtions may be here demanded:

1. How may the Center be found? 2. How may ſuch a Portion of Land be truly protracte and computed?

To the firſt I anſwer, that the moſt exact an artificial Way, is, by making a Mark any wher in the Arch.

As for Example.

At the Point C, and then (by a Proble known not only to every Surveyor, but to ordinary Carpenters and Joyners, for finding the Center of a Circle, whoſe Circumference will pa through 3 given Points that are not in a righ Line, as ACB) to find the Center O. But if yo know not how to do it ſo, croſs the Line A B i the Middle, as here it is done by the Perpendicula OC; ſo you may by a few Trials find both th due Extent of your Compaſſes, and the Point i

th

the Perpendicular that will fit your Purpoſe near enough; for if a little Error be committed in making up the Sector, the moſt of it goes off again in the Subſtraction of the Triangle.

II. For the latter, you may take this ready Courſe: Meaſure the Length of both your Lines, (the Chord and the Arch) and their Diſtance at the Middle of them both; then, when you come to protract, firſt take the Length of your right Line from the Scale, and having laid it down, croſs it in the Middle at right Angles with a dry Line, as in the laſt Figure, ſo ſhall it interſect the Line A B in the Point E; then from the ſame Scale take the meaſur'd Diſtance between the two Lines in the Middle, and ſet it upon that dry Line from the Interſection at E, to the Point C. Then, by Tryals, find a due Place in the dry Line O E C, and ſuch a Diſtance with your Compaſſes, that the one Foot reſting in that Line, the other may deſcribe the Arch A C B, and the Section is protracted.

Theſe few Hints are as much as I thought neceſſary for my Country Practitioner concerning circular Lines; but if he think otherwiſe, there are large Treatiſes enough, and particularly thoſe I mention'd, whoſe Rules (tho' ingenious, ſound, and fit to be known by every one that intends to plunge deep into mathematical Studies) will not, I think, be of that Uſe to him in ordinary meaſuring, that I ſhould tranſcend the intended Bounds of Brevity to tranſcribe them.

CHAP. VIII.

Concerning Cuſtomary-Meaſare, and how it may be reduc'd to Statute-Meaſure, & e contra, *either by the Rule of Three, or a more compendious Way by Multiplication only.*

WHereas the Statute-Perch or Pole is 16 Feet and a half, and no more, there be Poles of larger Meaſure us'd in many Places, as of 18, 20, 21, 24, and 28 Feet, yea, in ſome 22 Feet and a half. It were therefore very convenient that our young Surveyor were furniſh'd with a Chain fitted to the cuſtomary Meaſure of the Country where he lives, as I uſe to make Chains for my ſelf and Scholars of 21 or 24 Feet to the Pole for *Lancaſhire* and *Cheſhire*, where thoſe Meaſures moſt obtain. But becauſe theſe are too large and cumberſome for ſmall Cloſes, it is very convenient, inſtead of one Chain of 100 Links, to make two of 2 Poles apiece, each Pole divided into 25 Links, as that of 100 is; which two half Chains may, in meaſuring large Fields, be ty'd together by the Loops with Pack-thread, or join'd by a buttoning Keyring for more ſpeedy Diſpatch; but in ſmaller we may uſe the half Chain of 50 Links, only taking Care that we count not half Chains for whole ones.

And in theſe Caſes where the Poles are large, and the Cloſes ſmall, it were ſtill more convenient if you had a Chain of 2 Poles only, divided into 100 Links. Only you muſt then take Notice, that whereas Working by whole Chains and Links, the firſt Multiplication, after five cut off, gives the Content in Acres and Parts. The like Work by half Chains and half Links, will give the Content in Roods or Quarters of Acres, and Parts of ſuch Roods.

But though it is no hard Matter (for one that can find out the Length of a Link by dividing the Number of Feet in a Chain by a 100, and provide himſelf of good Iron-Wyer and Curtain-Rings to make it of, and a ſharp-edg'd File, and round-nos'd Plyers to make it with) to be furniſhed with ſuch a Chain, yet becauſe every one cannot do this, I ſhall ſhew you how you may eaſily, and yet very truly reduce Statute-meaſure into Cuſtomary, that ſo the Chain before deſcrib'd may do your Buſineſs all *England* over.

Know therefore (for a Ground to go upon) that Acres bear Proportion to one another as the Square of their Poles; and therefore if you multiply 33, the Number of half Feet in the Statute-pole, by it ſelf, which gives 1089, and alſo multiply the Number of half Feet contain'd in a Pole of that Meaſure you would reduce into; in the ſame Manner you may, by the Rule of Three reverſe, obtain your Deſire, making to that Purpoſe 1089 the firſt Number, the Statute-meaſure the ſecond, and the ſquar'd half Feet of the Pole given the third. As for Example: Suppoſe of a Cloſe meaſur'd by the Sta-

```
  9.33 L.
  7.21 B.
 -------
    933
   1866
  6531
 -------
 672693 prod.
```

tute-Pole, the Length and Breadth, and their Product be as here repreſented in the Margin. And it is deſir'd that the Content may be caſt up according to our large *Cheſhire* Meaſure of eight Yards, or 24 Feet to the Pole or Rood (as we call it:) Then, before I cut off any Figures, I conſider that in the Statute-Pole are 33 half Feet, and in the *Cheſhire* Pole 48; then multiplying 33 by 33, and 48 by 48, I have theſe two ſquare Numbers, 1089 and 2304, which, together with the ſaid Product, may be thus plac'd: 1089, 672693 : : 2304, and ſo multiplying 672693 by 1089, and dividing their Product, being 732562677 by 2304, the Quotient is 317952; from which, if 5 Figures towards the right Hand be cut off, and dealt withal as was taught in the fifth Chapter, the Content, by our Cuſtomary-Meaſure of 24 Feet to the Pole, will be 3 Acres, 0 Roods, 28 Perches, as here appears:

```
 3|17952
       4
 -------
  |71808
      40
 -------
28|72320
```

But if the Lines on the Land had been meaſured according to our Cuſtom here of 24 Feet to the Pole, and the Content muſt have been found according to Statute-Meaſure, then I muſt have multiply'd the Product by 2304, and have divided that latter Product by 1089. And in the ſame

Method you may proceed in all or any of the reſt. But the Truth is, that though this Way be very exact, plain, and comprehenſive, ſuiting all the Cuſtomary-Meaſures before-mention'd without Fractions, which for my Learner's ſake I ſtudiouſly avoid, and for that Reaſon reduc'd my Poles to half Feet, it is ſomething tedious, except he knows how to relieve himſelf by a large Table of Logarithms, or at leaſt a ſet of *Nepair*'s-Bones; which I cannot ſtand here to treat of. Therefore to contract the Work a little, take Notice, that all the Cuſtomary Poles being mention'd, (ſaving only thoſe of 20 and 28 Feet) which I ſuppoſe are ſomewhat rarely us'd, becauſe I never heard nor read of them, (to my Remembrance) ſave only in Mr. *Holwell*; all the reſt, I ſay, are capable of being divided into half Yards: And therefore, if inſtead of ſquaring the half Feet, you ſquare the half Yards of both Poles, and work with them, you will attain the ſame End without any regardable Difference, the ſmall Diverſity that there is, being uſually in the uſeleſs Remainders, not at all affecting the deſir'd Quotient that gives the Anſwer near enough for Uſe.

As for Example.

If I had ſquar'd 11 the Number of half Yards in the Statute-Pole, which would make 121, and alſo 16 the Number of half Yards in our *Cheſhire*-Pole, which would make 256, as appears in the Margin, and then multiply'd the firſt Product 672693 by 121, the ſecond Product would have been 81319853, which being divided

```
 11
 11
---
 11
11
---
121
```

by 256, the Quotient would have been (as
16 before) 317952. And this Way is in a
16 manner co-incident with Mr. *Holwell*'s firſt
—— Method.
96

16 Take Notice alſo farther once for all, that
—— whether you uſe either of theſe or the following
256 Methods, you need not reduce the
particular Squares, Triangles, or Trapezia's ſeverally; but ſum up all their Products together, and then reduce all at once.

But if you would reduce Statute-Meaſure into Cuſtomary by Multiplication only, take Notice of this preſent Table following.

The Content by the Statute-Pole being multiply'd by	Gives the Content by the Pole of	Feet.
.84027	18	
.68062	20	
.61734	21½	
.53777	22	
.47265	24	
.34725	28	

The Uſe of this Table.

When you have multiply'd Lengths by Breadths, or Baſes by half Perpendiculars, multiply theſe Products by the decimal Fractions anſwering to the Cuſtomary-Meaſure, into which you would reduce Statute-Meaſure, and from that latter Product, firſt cut off five Places towards the right Hand, as not to be regarded, (being only Parts of a ſquare Link) then cutting off five more, and proceeding to multiply by 4, and then by 40, as hath been often ſhewn, you will have the Content by that Cuſtomary-Meaſure.

Example.

Suppoſe once more the Length of a Cloſe meaſur'd by *Gunter*'s Chain, and multiply'd by the Breadth meaſur'd alſo by the ſame, produc'd 672693 ſquare Links; and it is deſir'd, that the Content may be given in *Cheſhire* Meaſure of 24 to the Pole; you muſt multiply 672693 by 47265, the decimal Fraction anſwering to 24 Feet, and from that Product, being 31794834645, cut off and caſt away 5 Places, and the reſt being 317948, are in the uſual Way eaſily reducible into 3 Acres, 0 Roods, and 28 Perches, as here appears, agreeable to what it amounted to in the former Method.

$$\begin{array}{r} 3|17948 \\ 4 \\ \hline |71792 \\ 40 \\ \hline 28|71680 \end{array}$$

But if you meaſur'd by a Chain of Cuſtomary-Poles, and deſire to know what the Content is in Statute-Meaſure, this following Table is for your Purpoſe.

	Feet.			
The Content meaſur'd by the Pole of	18	being multiply'd by	1.19008	gives the Content by the Statute-Pole.
	20		1.46923	
	21		1.61983	
	22½		1.85950	
	24		2.11570	
	26		2.87970	

To underſtand which, take this Example.

Suppoſe the Length and Breadth of a long Square being meaſur'd by a Chain of 24 Feet to the Pole, and multiply'd together, make their Product 317952, let this be multiply'd by 2.11570, which anſwereth to 24 Feet, and the latter Product will be 67269104640; from which, if you cut off and caſt away 5 Places towards the right Hand, the Remainder is 672691; which, in the uſual Way, is eaſily reduc'd to 6 Acres, 2 Roods, and 36 Perches, as you ſee here.

```
 6|72691
      4
--------
 2|90764
     40
--------
36|30560
```

One Thing more, and I have done with this Buſineſs of Reduction. If the Content to be reduc'd, be given caſt up into Acres, Roods, and Perches, reduce all into Perches, and then in other Reſpects work as before, either by the Rule of Three, or by this laſt Method of Multiplicaon only. So ſhall you have the Content in ſquare Perches, according to the Meaſure deſir'd, which you may reduce into Acres by dividing them by 160; and if any Thing remain, that Remainder being divided by 40, will give you the Roods in the Quotient, and the latter Remainder the Number of ſquare Perches.

For Tryal of which Rules, mind the Anſwer of theſe two following Queſtions wrought all three Ways.

Queſt. 1. *How many Acres, Roods, and Perches, according to the Pole of* 18 *Feet, are contain'd in* 5 *Acres,* 3 *Roods, and* 11 *Perches, Statute-meaſure?*

Anſw. 4 Acres, 3 Roods, and 22 Perches, as here appears.

I. Method.

A. R. P.
33 36 5 : 3 : 11
33 36 4

99 216 23
99 108 40

1089 1296 931

1089. 931 : : 1296
1089

8379
7448
9310
1013859

1296) 1013859 (782
9072

10665
10368

2979
2592

387

160) 982 (4
640

40) 142 (3
120

22

II. Method.

II. Method.

```
   11       12       121 .  931 : : 144
   11       12              121
  ----     ----            -----
   11       24              931
  11       12              1862
 ----     ----             931
 121      144             ------
                    144) 112651 (782
                         1008
                        ------
                          1185
                          1152
                         ------
                           331
                           288
                          -----
                            43
160) 782 (4  )         (  40) 782 (19
     640     )   Or    (      40
    -----    )  thus:  (     -----
40) 142 (3   )         (      382        4) 19 (4
    120      )         (      360           16
   -----                     -----         ----
                               22            3
    22
```

III. Method.

III. Method.

.84027
931

84027
252081
756243

782.291 37

160) 782 (4
640

40) 142 (3
120

22

Queſt. 2. *How many Acres, Roods, and Perches of Statute-Meaſure, are contain'd in 8 Acres, 3 Roods, (or Quarters) and 21 Perches of 21 Feet to the Pole?*

Anſw. 14 Acres, 1 Rood, and 21 Perches, as appears by the three following Works in the ſeveral Methods.

I. Method.

A. R. P.
8 : 3 : 21
4

35
40

1421

42
42

84
168

1764

33
33

99
99

1089

1764.

1764 . 1421 : : 1089
1764

5684
8526
9947
1421

1089) 2506644 (2301
2178

3286
3267

1944
1089

855

160) 2301 (14
160

701
640

40) 61 (1
40

21

II. Method.

II. Method.

```
 14 . . 11       196 . 1421 : : 121
 14 . . 11              196
 ----   ----           -----
 56     11             8526
 54     11            12789
 ----   ----          1421
 196    121           ------
        121) 278516 (2301
             242
            ----
              365
              363
             ----
               216
               121
               ---
         160) 2301 (14  95
               160
               ---
               701
               640
               ---
               61
                  40) 61 (1
                      40
                     ----
                      21
```

III. Method.

```
     1.61983        160) 2301 (14
        1421              160
    ---------            -----
      161983              701
     323966               640
    647932               -----
   161983            40) 61 (1
  -----------              40
   2301.77843             ----
                           21
```

CHAP. IX.

How a Man may become a ready Meaſurer by Practice in his private Study, without any One's Aſſiſtance or Obſervation, 'till he deſign to practiſe Abroad.

THis Art, above all Parts of the Mathematicks, is burden'd with two Inconveniencies to the young Practitioner: The Neceſſity of having one to aſſiſt him in meaſuring his Lines with the Chain, as oft as he would practiſe his Skill, or get more; and the expoſing of his Unreadineſs to the View of middleſome People, while he is yet raw and unexperienc'd, as every one muſt needs be at firſt: Both which may in a good meaſure be avoided by this eaſy Knack.

Take a ſmall Pack-thread, and by Knots above half an Inch aſunder, divide it into an 100 Parts, as *Gunter*'s Chain is divided ; ſo ſhall theſe ſmall Diviſions between the Knots, anſwer to Links ; and if they be not exactly of one Length, the Matter is not very weighty, but the more equal and ſhort they are, the better. Having this String thus prepar'd, and mark'd with longer and ſhorter Pieces of thread ty'd in the Knots, ſo as you may readily ſee where is the Middle, and where your Diviſions of 25 Links, and the ſmaller Diviſions of 10 Links begin and end ; make all ſorts of Figures in your Study or Chamber by marking Places, or ſticking Knives or Bodkins at pleaſure for Angles, accounting the ſtreight Lines betwixt them for Sides, and ſo meaſure the Figures by your knotted String, and caſt up the Content by a Scale. This Work you may manage with your own Hands in private, and ſo make your ſelf very quick and ready when you begin to meaſure for good and all, as I once made a full Experiment, and it was thus :

When I firſt began to inſtruct Youths in mathematical Learning in *Warrington*, ſome of my Boys Parents deſir'd a ſenſible Dmonſtration of their Sons Proficiency in ſomewhat that they themſelves could in ſome meaſure underſtand ; and particularly pitch'd upon meaſuring a Piece of Land : Whereupon I took four or five of my Scholars to the Heath with me, that had only been exerciſed within the Walls of the School, and never ſaw (that I know of) ſo much as a Chain laid on the Ground ; and to the Admiration of the Spectators, and eſpecially of a skilful Surveyor then living in the Town, they went about their Work as regular, and diſpatch'd it with as much Expedition and Exactneſs, as if they had been old Land-meeters.

CHAP. X.

How to meaſure a a Piece of Land with any Chain of what Length ſoever and howſoever divided; yea, with a Cord or Cart-Rope, being a good Expedient when Inſtruments are not at Hand of a more artificial Make.

IF you can procure a Chain, and find it is not divided as before hath been ſhewn, but into Feet or quarters of Yards, or any ſuch vulgar Diviſions, make no reckoning of the Diviſions at all, but meaſure it as exactly as you can find out the true Length of the whole Chain; and if it fit none of thoſe Lengths mention'd in the 8th Chapter, nor any of their Halfs, make it fit by taking off a Link or two, or piecing it out with a String; then dividing the Length of that Chain by 100, or the half of it by 50, find the true Length of a Link according to our artificial Diviſions, and having got a long Stick or Rod, ſet as many of thoſe Link-Lengths upon it as it will hold; then may you meaſure all the whole Chains by your regulated Chain, and the odd Links of every

Line by your divided Stick or Rod, as is manifeſt in this Example following.

Being far from my Inſtrument, and requeſted by a Friend to meaſure him a Cloſe, I procure a Pair of Compaſſes, an ordinary Carpenter's Rule of two Foot, divided into Inches and Quarters, and meeting alſo with a Piece of an old Chain ſeemingly divided into Feet, I meaſure it by the Rule, and finding it to be 45 Feet long, and ſome odd Meaſure, I piece it out with a pretty ſtrong Cord that will not ſtretch much, to 48 Feet exactly; then it will ſerve for half a Chain of 24 Feet to the Pole: This 48 I multiply by 12, (the Number of Inches in a Foot) and that Product being 576, I divide by 50, (the Number of Links in half a decimal Chain) and the Quotient is $11.\frac{66}{50}$ Inches, or 11 Inches and an half, and a trifle over: So then dividing a long Stick throughout into ſuch Parts, each containing 11 Inches and a half, beſides the Breadth of the Nicks, I am provided of Tools to meaſure Lines to a Link with Exactneſs enough.

In like manner would I proceed with a Cord or Rope, having fitted them to ſome known Length or other; and then for protracting, it were eaſy with the Compaſſes to make a plain Scale of a large Sort, either upon Paper, or an even piece of Wood. This for once may ſerve a Man's Turn well enough.

Beſides, there is a Way of meaſuring the Perpendiculars of Triangles and Trapezia's upon the Ground it ſelf, ſo as to prevent the Neceſſity of a Scale; for if you have a little Square with a Hole in it, to turn upon the Head of a little Stick, which you may fix where you pleaſe, as you are meaſuring the Baſe of a Triangle, or the Diagonal of a Trapezium, you may by a very few Tryals find the Place where the one Leg will be juſt in the Line you are meaſuring, and the other Point at the Angle from which the Perpendicular falls on it, and then the Space between your Stick and that Angle truly meaſur'd, is the Perpendicular.

If you have not ſuch a Square, a ſquare Trencher, or any end of a Board that hath one right Angle, and two true Sides, will ſupply the want of it.

And now that I am mentioning this Way of Meaſuring, I ſhall make bold to add, that this is a good Way (and as ſuch ordinarily us'd by that general Scholar and reverend Miniſter Mr. *Samuel Langley* of *Tamworth* in *Staffordſhire*, whoſe ancient Acquaintance I have long eſteem'd both my Happineſs and Honour) to meaſure a Trapezium thus, though it be protracted afterwards; for by meaſuring the Perpendiculars as aforeſaid, and obſerving at how many Chains and Links end the ſaid Perpendiculars meet the common Baſe, the whole Trapezium may be truly protracted without going about it; this little Square competently ſupplying the place of an Inſtrument, which is uſually call'd a Croſs or Square, made up (as it were) of two ſmall Indices, like thoſe for a plain Table (but much leſs) with fore-ſights and back-ſights, and cutting one another at right Angles put together, and having an Hole at the Center, like thoſe Things which here in *Cheſhire* we call *Yarndles*, being us'd by Country Houſe-wives in winding of their Yarn.

CHAP.

CHAP. XI.

Concerning dividing of Land artificially and mechanically.

WEre it ſuitable to my Deſign or Humour to be copious or curious, I had here a fair Opportunity; for four or five modern Survey-Books of the beſt Account lying open before me, would tempt me to tranſcribe abundance of ingenious Things; but for Reaſons often hinted before, I ſhall confine my Self to a few plain Things that will competently do this Buſineſs.

1. To divide a Triangle into any Parts requir'd; divide the Baſe as the Demand imports, then ſhall Lines drawn from the Points of Diviſion to the oppoſite Angle, finiſh the Diviſion of the Triangle.

Example.

Fig. 20. AC, the Baſe of the Triangle ABC, being divided into 12 equal Parts, a Line drawn from the angular Point B to the Point 6, divides the Triangle into two equal Parts; 2 Lines drawn to 4 and 8, divide it into three equal Parts; 2 Lines drawn to the Points noted with 3, 6, and 9, divide it into four equal Parts; and ſo Lines drawn to 2, 4, 6, 8, 10, divide it into ſix equal Parts.

Alſo it is very obvious, that if the ſame Triangle were ſo to be divided, that the one Part ſhould be double to the other, a Line drawn from

B to 4 or 8, doth the Work. Or if it be requir'd to divide it into two Parts, ſo as the one ſhall be triple to the other, a Line drawn from B to 3 or 9, compleats the Work. So alſo a Line from B to 2 or 10 divides it into two Parts, whereof the one is quintuple (or five-fold) to the other, and a Line from B to 1 or 11, divides it into two Parts, whereof the one is 11 times as large as the other.

Farther yet, if it were requir'd this Triangle ſhould be ſo divided, that the two Parts ſhould in Quantity bear Proportion, as 5 and 7, a Line from B to 5 or 7, doth that Feat.

But to deal plainly with you, I muſt confeſs that ſometimes the Diviſions will be a little more intricate than thus, yet not ſuch, but that the ſeeming Difficulty may be eaſily overcome by obſerving the Method wherein I ſhall ſatisfy the following Demand.

Suppoſe a large Triangle of common Land to be divided amongſt three Tenants, A, B, and C, according to the Quantity of their Tenements, A, having 19 Acres of Land to his Tenement, B 13, and C 7, the Baſe of the Triangle being found by Meaſure to be 17 Chains and 27 Links; and the Demand is, where the Point of the Diviſion muſt be plac'd in the Baſe, ſo as Lines drawn from thence to the oppoſite Angle, ſhall truly limit each Man's Part?

To anſwer this, let us add 13 and 07 to 19, (as in the Margin) and they give 39: So is the Work plainly reduc'd to the Rule of Fellowſhip; and therefore to find every Man's diſtinct Portion, we need only to multiply the Baſe by his particular Number, and divide

19
13
07
—
39

that Product by 39, the Sum of all their Numbers, as here is plain:

A

29 . 17.27 :: 19
19

15543
1727

39) 32813 $(841\frac{14}{39}$
312

161
156

53
39

14

B

39 . 17.27 :: 13
13

5181
1727

39) 22451 $(575\frac{26}{39}$
195

295
273

221
195

26

C

39 . 17 . 27 :: 7
7

39) 12089 $(309\frac{38}{39}$
117

389
351

38

From theſe Operations it is plain, that if we ſet off from the angular Point where the Baſe begins, 8 Chains, 41 Links, and a little above the third Part of a Link upon the Baſe for A, and where that ends, 5 Chains and 75 Links and $\frac{2}{3}$ of a Link for B, and conſequently leave between this ſecond Diviſion and the other End of the Baſe 3 Chains and almoſt 10 Links for C; Lines drawn from thoſe Points of Diviſion to the oppoſite Angle, will give each Man his Due.

☞ What I have ſaid touching the Diviſion of Triangles upon their Baſes, will, with a little Variation, ſerve for the dividing of all Sorts of Parallellograms, whether Squares, long Squares, Rhombus's, or Rhomboides; all the Difference is, that inſtead of drawing Lines from Points in the Baſe to the oppoſite Angle, you muſt draw parallel Lines from Points in one oppoſite Side to another, as will be ſufficiently plain by this one Inſtance.

Fig. 7. Suppoſe the ſquare Figure in the 8th Prop. of the ſecond Chapter to repreſent a Cloſe of ſix Acres, and I am to cut off an Acre at the Side A C, having ſet off the 6th Part of the Line C D, from C towards D, and alſo from A towards N, a Parallel drawn between thoſe Points, takes off exactly a ſixth Part of an Acre.

If it be not thought convenient (as in ſome Caſes it is not) to cut off a Piece ſo long and narrow, you may by the Rule of Three find what other Length of any greater Breadth will limit an equal Quantity to it. Or you may multiply the Breadth by 2, 3, or any other, and divide the Length by the ſame Number that you multiply'd ply'd the Breadth by. Or laſtly, if you ſet out a double Proportion that is $\frac{2}{6}$ or $\frac{1}{3}$, from C towards D, and from the Point where it falleth, draw a Line to the Angle A, you will have a Triangle equal to $\frac{1}{6}$ of the Square ACDN.

But to return to Triangles, (the moſt ſimple and primitive of all Rectilinears, and therefore the moſt conſiderable in this Caſe of Partition, as giving Laws often to the reſt) it may fall out that a Triangle muſt be divided (Convenience ſo requiring) by a Line from ſome Point in a Side, ſo as that Line may either be parallel to ſome other Side, or not parallel to any. For the former Caſe, take this Example following out of Mr. *Wing*, *Lib.* 5. *Prob.* 5.

Fig. 21. Let A B C be a Triangle given, and it is requir'd to cut off $\frac{3}{5}$ by a Line parallel to A B. Firſt, on the Line A C deſcribe the Semi-circle A E C, whoſe Diameter C A divided into five equal Parts according to the greater Term, and upon three of thoſe Parts (the leſſer Term) erect the Perpendicular D E, which cutteth the Arch Line in E; then ſet the Line from C E from C to F, and from thence draw the Line E G parallel to A B; ſo will the Triangle C G F contain $\frac{3}{5}$ of the Triangle A B C, as was requir'd.

Fig. 22. Now, for the latter Caſe, when the Line of Partition goes not parallel with any Side, take this Example:

Let A B C be a Triangle given to be divided into two Parts which ſhall bear Proportion to one another, as 3 and 2, by a Line drawn from the Point D in the Baſe, or Line A C.

From the limited Point D, draw a Line to the Angle B; then divide the Baſe A C into five equal Parts, and from the third Point of the Diviſion draw the Line to E parallel to B D. Laſtly, from E draw the Line E D. So ſhall the Trapezium ABED be in Content as 3 to 2, to the new Triangle DEC.

I have now done with the Diviſion of Triangles, when I have added theſe three Advertiſements.

1. You muſt be ſure to take very exactly the Diſtance of every Point, where a dividing Line cutteth any Side, to one of the ends of the ſame Side, as in this laſt Figure, the Diſtances BE and AD; which Diſtances being apply'd to the Scale by which the Triangle was protracted, will ſhew at how many Chains and Links end you are to make your dividing Line on the Field it ſelf.

2. The Proportions by which you are to divide, are not always ſo formally given as in the former Examples, but are ſometimes to be found out by Arithmetical Working, as in this Caſe.

Suppoſe a triangular Field of 6 Acres, 2 Roods, and 31 Perches, muſt be divided ſo as the one of the two Parts ſhall be four Acres, 3 Roods, and 5 Perches, and the other (conſequently) 1 Acre, 3 Roods, and 26 Perches; reduce both Meaſures into Perches, and the one will be 705, and the other 306. Their Sum is 1701, which, by their common Meaſure, being reduc'd into their loweſt Terms of Proportion in whole Numbers, will be 5, 2, and 7, which ſhews that the Triangle being divided in 7 equal Parts, the one muſt have 5 of thoſe 7 Parts, and the other 2. And obſerve, that it will be ſufficient to find the common Meaſure between the Sum of your Terms, and either of the Terms; the Method whereof is ſhewn in every Arithmetick-Book for reducing Fractions into their loweſt Terms.

But if my unlearn'd Reader cannot skill of that Work, he may multiply either of the Parts; (as ſuppoſe (765 by the Length of the Baſe, which we will ſuppoſe to be 8 Chains and 75 Links, or 87, Links; and that Product divided by 1071, (the Content of the whole Cloſe in Perches) gives the Rule of Three direct, 625 Links, or 6 Chains and 1 Pole, the true Diſtance from either end of the Baſe, that his Mind or Occaſions may direct him to begin with, to the Point of Diviſion; for the Diviſion muſt be not only for Proportion or Quantity, but alſo as to Poſition or Situation of Parts upon the Paper, as it is requir'd to be on the Ground.

3. In theſe and all other Diviſions of Land, where a ſtrict Proportion in Quantity is to be obſerved, you muſt have reſpect to the Rules hereafter following, concerning Meaſuring of uneven Ground, *Chapter* 15. eſpecially if one Part prove much more uneven then another: And if their be any uſeful Pond, or Well to draw your Line of Diviſions through it; but if it be an unuſeful Pond, Lake, or Puddle; or if there be any boggy or barren Ground, that muſt be caſt out in the Diviſions, meaſure that firſt, and ſubſtract it from the Content of the whole Cloſe, and then lay the juſt Proportion of the Remainder on that Side that is free from it, that the other may have its juſt Part alſo, beſides that which is uſeleſs.

What hath been ſaid, with an ordinary Meaſure of Deſcretion, may ſufficiently inſtruct a young Artiſt to divide Triangles, Parallellograms, and regular Polygonials, in an artificial Way; but becauſe many Cloſes and open Grounds are Trapezia's, and many irregular Polygons, and even thoſe that are regular enough, may fall under an irregular Diviſion, in Regard of the Quality of the Land, Woods upon it, or Quaries in it, or the Conveniences of Ways, Currents of Water, Situation in reſpect of adjacent Lands, *&c.* I ſhall propoſe a Method, which though it hath ſomewhat of the Mechanick in it, will be ſingularly uſeful in ſuch Caſes.

Let A B C D be a Trapezium to be divided betwixt a young Heir and his Mother, ſo as his Part may be double to her's. Having by the Diagonal B C divided it into two Triangles, I find the Content of the Triangle A B C to be 138550 ſquare Links, and the Triangle B C D to contain 103468, in all 242018 ſquare Links, which, if reduc'd, as hath been formerly taught, would amount to 2 Acres, 1 Rood, and 27 Perches, (for which, ſee *Chap.* 5.)

But as to my preſent Work, they are in a better Order already. Dividing then 242018 into three Parts, each of them is 80676 and $\frac{2}{3}$, two therefore of thoſe third Parts muſt contain 161353 and $\frac{1}{3}$, which $\frac{1}{3}$ being inconſiderable, I regard not.

Then reſolving to lay out the double Part towards the Line B D, I ſtrike at Adventures the Line E F, and meaſuring the Trapezium bounded by that Line, and the oppoſite Side B D, together with the interjacent Parts of the Lines A B and C D, I find it to contain 119140 ſquare Links; but becauſe it ſhould have been 161353, I ſubſtract 119140, out of 161353, and their Difference is 42213, and perceiving that the Lines A B and C D are very near parallel, and finding their Diſtance where they are cut by the Line E F, to be 326 Links, or 3 Chains and 26 Links, I divide 42213 by 326, and the Quotient is 129 Links and almoſt half, at which Diſtance I draw the Line GH parallel to E F; ſo ſhall the Trapezium GB D H be the Heir's Part.

Another way whereby this may be perform'd, is thus: Finding the Triangle A B C to contain 138650 ſquare Links, ſubſtract it out of the Heir's Part, *viz.* 161353, the Difference 22803, ſhews how many ſquare Links muſt be taken out of the Triangle B C D, and added to the Triangle A B C; which to perform with all neceſſary Exactneſs, ſuppoſe the Side or Line BD to be the Baſe, which by Meaſure proves to be 344 Links, or 3 Chains, and 44 Links. Say by the Rule of Three direct, if the whole Content of the leſſer Triangle, *viz.* 103468, give 344; what ſhall 22803 give? So will the Reſult be 75 Links, and ſomewhat more than $\frac{4}{5}$, or a Link, for 22803 multiply'd by 344, gives 7844232, which being divided by 103468, the Quotient is $75\frac{184132}{03468}$; or (according to decimal Diviſion) 75,8131, which is (as I ſaid before) ſomewhat more than 75 Links and $\frac{4}{5}$, wherefore extending your Compaſſes upon the Scale to almoſt 76 Links, ſet that Diſtance upon the Line BD, from B to I, and draw the Line C I: So ſhall the Trapezium ABIC be double to the Triangle I C D, within ſo ſmall a Matter as is not worth regarding, though the Land were a rich Meadow.

I hope I need not ſtand to tell any Man of Senſe, that if he pleaſe he may begin with the leſs Part, and take out that; or if there be many Partners, he may divide betwixt any one and all the reſt, (putting their Parts together) and then by the ſame Method ſub-divide amongſt them 'till each hath his due Share; nor to ſpend many Words in telling him he muſt ſubſtract where he hath, by ſeparating a Line at Adventures, or by chooſing out a Triangle, taken too much, as I added, when I took too little. Nor laſtly, that theſe Methods are not only applicable to Trapezia's, but to any triangular Figure whatſoever, whether regular or irregular.

CHAP. XII.

Concerning the Boundaries of Land, where the Lines to be meaſur'd muſt begin and end.

IF there be no Agreement between the Parties concern'd, (for if there be, that muſt be obſerv'd) Reaſon and Cuſtom are the Surveyor's Guide.

The Farmer ſpeaks loudly, that when a Piece of Arable or Meadow-land, is let for a Year to be ſown or mown, no more ſhould be meaſur'd, nor expected to be paid for, either to the Letter or Work-men, than the Plow or Scythe can go over. So alſo when a Parcel of Land is let for Paſture by Meaſure to a Farmer, it ſeems very reaſonable, that all, and only ſo much ſhould be meaſur'd, as is uſeful to that Purpoſe.

But Commons to be incloſ'd are uſually meaſur'd (except it be otherwiſe agreed) to the uttermoſt Bounds of every Man's particular Proportion, without any Allowance for Ditch or Fence, every Man being to make them upon his own of what Breadth he pleaſes. Nor is this unreaſonable; for 'tis as good for one as another, and the Rate paid to the Lord is uſually very little, ſometimes nothing.

It is alſo very uſual in meaſuring betwixt Lord and Tenant, in Caſe of Leaſes for Lives, and long Terms of Years, to extend the Lines to the utmoſt Bounds of the Tenant's Claim, taking in the very Walls, Hedges, and Ditches: But this is accounted very hard, and oft proves very unequal among the Tenants of a Lordſhip, ſome being forc'd to make much more Waſte of their Ground this Way, than others that hold as much or more. But where the Cuſtom obtains, the Surveyor muſt obſerve it; for it is others Work to appoint what muſt be meaſur'd, and his only to meaſure truly what is ſo appointed. A good Landlord may (and will be apt) to conſider it in his Rates, and a bad one 'tis like will be tenacious of a Cuſtom to his own Advantage.

Laſtly, In Caſe of a Sale by Meaſure at a Rate agreed upon *per* Acre, (no Boundaries being ſpecify'd in the Bargain) the Rule (as I had it from an old famous Surveyor many Years ago) is to extend the Lines to the quick Wood-row, that is, as Reaſon prompts me to underſtand him, to the Place where the quick Wood actually groweth, or where, according to Cuſtom, it ought to be ſet.

I confeſs theſe Things are trivial, but yet more neceſſary to be known, than many artificial Things much ſtood upon, for a young Artiſt, whom Ignorance of theſe Things may expoſe to conſiderable Miſtakes in Practice.

CHAP. XIII.

Containing a Deſcription of the plain Table, the Protractor, and Lines of Chords.

THO' what hath been already ſaid, may competently ſuffice to inſtruct my young Artiſt in meaſuring a Cloſe of Land, yet, to advance him a Degree higher in uſeful Knowledge, I ſhall take Occaſion to deſcribe unto him the plain Table, which, with Mr. *Wing*, I account the beſt of all fix'd Inſtruments. This Inſtrument conſiſts of ſeveral Parts.

1. The *Table* it ſelf, which is a Parallellogram of Wood fourteen Inches and a half long, and eleven Inches broad, or thereabouts, and for Neceſſity may be made by an ordinary Country Workman of one Board; but for Neatneſs, Convenience of Carriage, and Freedom from warping, it is uſually made of three little Boards join'd together ſide Ways, with a Ledge at each End to hold

them faſt together, and upon the Middle Board, a Socket of Braſs fix'd with three Screws, and with a fourth to be faſten'd on the Head of a three-legg'd Staff; of which anon.

2. A Frame of Wood fix'd to it, ſo as a Sheet of Paper being laid on the Table, the Frame being forc'd down upon it, ſqueezeth in all the Edges, and makes it lie firm and even, ſo as a Plot may be very conveniently drawn upon it. This is uſually made with Joints for more eaſy Carriage, but a plain one may ſuffice. Upon one Side of this Frame ſhould be equal Diviſions, for drawing parallel Lines both long-wiſe and croſs-wiſe (as Occaſion may require) over your Paper, and on the other Side the 360 Degrees of a Circle projected from a Center of Braſs conveniently plac'd in the Table.

3. A Box with a Needle and Card, to be fix'd with two Screws to the Table, very uſeful for placing the Inſtrument in the ſame Poſition upon every Remove.

4. A three-legg'd Staff to ſupport it, the Head being made ſo as to fill the Socket of the Table, yet ſo as the Table may be eaſily turn'd round upon it, when 'tis not fix'd by the Screw.

5. An Index, which is a large Ruler of Wood, (or rather Braſs) at the leaſt ſixteen Inches long, and two Inches broad, and ſo thick as to make it ſtrong and firm, having a ſlop'd Edge, (by which we draw the Lines) call'd uſually the fiducial Edge, and two Sights of one Height (whereof the one hath a Slit above, and a Thread below, and the other a Thread above, and a Slit below) ſo ſet in the Ruler, as to be perfectly of the ſame Di-

Diſtance from the fiducial Edge. Upon this Index 'tis uſual to have many Scales of equal Parts, and there might be a diagonal Scale if the Inſtrument-maker pleaſe, and Lines of Chords of ſundry Lengths; but if you have ſuch a Scale as I before deſcrib'd, you need not to have them here.

The *Protractor* is an Inſtrument ſo well known and ſo eaſy to be made and procur'd, that I ſhall be very brief in the Deſcription of it. As it is uſually made, it conſiſts of two Parts, a Scale and a Semi-circle, but the Scale is no neceſſary Part of it, but ſerving (if you be not otherwiſe provided) for other Uſes before-mention'd in the Caſe of plain Scales.

But the Semi-circle is more eſſential, and it may be made of Braſs, or other Metal of any convenient Size, as four Inches (more or leſs) for the ſtrait Side, this Semi-circle being bounded as all others are by two Lines, the one right or ſtrait, the other circular.

The right Line is divided in the preciſe Middle, by a Point which is in the Center, upon which the circular Boundary is drawn, and two other Arches concentrical with it.

The Center, when the Semi-circle goes alone without the Scale, ſhould be guarded with two little Lips, on each Side one, or a little Loop, for more convenient turning of the Inſtrument about upon a Pin fix'd in a Paper.

The arch'd or circular Edge is divided into 180 Degrees, or equal Parts, number'd by Tens, upon the upper concentrick Arch from 0 to 180, and in the lower from 180 to 360. So that by applying the ſtrait Edge of the Protractor twice to any Line, (keeping the Center right upon a Pin fix'd in the Line) that is, with the Semi-circle firſt above it, and then below it, or contrarily, you may draw a whole Circle by the Guidance of the Arch, or ſet out any Number of Degrees, as will appear more plainly hereafter.

A *Line of Chords* is a Line divided into 90 unequal Parts, whereof 60, and the Radius upon which the Circle was drawn, are equal, and the Diviſions upon that Line are equal to the next Extent in a right Line, of ſo many Degrees from the Beginning of the Quadrant, as anſwer thereunto.

When Lines of Chords are cut upon Wood, 'tis both uſual and neceſſary that there be two Studs of Braſs, the one at the Beginning, and the other at 60 Degrees, with little Holes for the Feet of the Compaſſes, when you take the Extent of the Radius, to preſerve the Line from being wounded by the Compaſſes; and being thus fenc'd, it will for need do the Work of a Protractor, but not altogether ſo commodiouſly.

CHAP. XIV.

How to take the true Plot of a Field by the plain Table, upon the Paper that covers it, at one or more Stations.

THere are three Ways or Methods for doing this Work, two more uſual and ordinary, the third more unuſual and extraordinary, though now pretty well known to moſt Surveyors, and in late Books publiſh'd. The firſt performs the Work by meaſuring every Line from the Inſtrument to every Angle, and is a very ſure ſubſtantial Way where it can be done, as it ordinarily may in moſt Cloſes.

The ſecond doth it by meaſuring only the Station or the Diſtances, and is very quick, but not ſo ſure and exact as the other; yet, if manag'd by a ſkilful Artiſt, that knows how to plant his Inſtrument, ſo as to avoid making acute Angles unneceſſarily, it will come near enough the Matter in many Caſes; as in meaſuring for Workmen, that take the mowing or reaping of Fields by the Acre, or when Tythes are let at a ſmall Value *per* Acre, as in poor barren Pariſhes they uſually are.

The third is the Way of Circulation or Perambulation, the Inſtrument being oft to be planted, and the Plot to be meaſur'd about; by which not only difficult Cloſes, but even the thickeſt Woods, yea, Bogs, Meres, and Pools of Water, may be plotted, which by neither of the other Methods can be perform'd.

In all theſe Methods, two Things are to be perform'd:

1. At every Angle where there is no perſpicuous Mark already, as a Tree, Buſh, Stile, *&c.* one muſt be plac'd, as a white Paper, or ſuch like; or elſe ſome one muſt go from Angle to Angle, and remain there as your Mark to look at, 'till you bid him remove to another; only

when Angles are near you, this Labour may be ſpar'd.

2. Whenever you have Occaſion to plant your Inſtrument more than once, (as it will often fall out in the firſt Method, and ever in the two latter) you muſt be ſure it ſtand juſt as it did the firſt Time for Situation; for which your Needle, if well touch'd and hung, will be good Direction, but is not thought ſufficient without Back-ſight and Fore-ſight (by ſome practical Surveyors.) I ſhall therefore in due Seaſon ſhew you that Knack. Now for the firſt Method.

I. When you go about to plot your Parcel of Land, find ſuch a Place in it, if poſſible, from whence you can ſee all the Angles, and in that Place plant your Inſtrument cover'd with a Sheet of Paper, and turning it about 'till the Needle playing at Liberty, hang over the Flower-de-luce, (or any other notable Place that you make Choice of) ſcrew it faſt. Then chooſing any convenient Place in your Paper for a Center; and to repreſent your Station, (or Place where you fix your Inſtrument) make a Prick with the ſmall Point of your Compaſſes; to which Prick applying the fiducial Edge of the Index, (which is eaſily done if you keep the Point of the Compaſſes reſting in it) direct the Index, by the Sight to all the Angles; and when through the Slit, or long Sight, you ſee the oppoſite Thread, cut the Mark in the Angle, draw a neat dry Line along the fiducial Edge, to or from the Center; then meaſuring from the Inſtrument to every Angle, ſet the Meaſure by a Seale and Compaſſes from the Center towards the Angle upon the

Line that points at it, making a Prick in the Line where the Chains and Links reckon'd from the Center do truly end ; then ſhall Lines drawn by a ſtrait Line from Prick to Prick, give you the perfect Plot upon your Paper, which you may divide (as hath been before ſhew'd) into Trapezia's and Triangles, and ſo find the true Content. To make which plain, mark this *Example*.

Fig. 24. Suppoſe A B C D E F G H to be a Field ; having planted my plain Table, as before directed, at a convenient Advantage, ſo as to ſee all the Angles, (as at I) I made a Prick to repreſent my Station in the little Circle ⊙ mark'd with I ; upon which laying the fiducial Edge of my Index, and directing the Sights to all the Angles, I draw dry Lines toward A, and all the reſt of the Angles in order from the Center ; and then meaſuring upon the Ground from the Inſtrument to the Angle A, I find it to be 3.45, which I ſet (by Help of my Scale) from the Center to the Point A, and ſo upon all the reſt according to their due Meaſures, and then black Lines drawn from Point to Point, as from A to B, from B to C, &c. limit the true Figure of the Field according to the Scale I us'd, *viz.* of 400 in an Inch.

And now, before I paſs to farther Varieties, let my Reader take Notice of theſe following Things.

1. From henceforth I ſhall forbear (for Brevity's Sake) to take any Notice of the Meaſures of Lines meaſur'd from the Inſtrument to the ſeveral Angles, having ſo often ſhew'd how to meaſure by a Scale.

2. When

From henceforth I shall for

2. When I ſpeak of meaſuring from or to the Inſtrument, I always mean from or to that Part of Ground that is perpendicularly under the Head of the Inſtrument, where you are to draw your Plot, which will ever be encloſ'd with the three Legs of your Staff.

3. That it's uſually the quickeſt Way to meaſure firſt from the Inſtrument to the firſt Angle, and then back from the ſecond Angle to the Inſtrument, and ſo the reſt in order, ſtill one from the Inſtrument, and the other to it.

4. It is no matter at all whether your plain Table be plac'd towards the Middle of a Field, as was repreſented in this Figure, or at an Angle, as will appear anon.

5. In all Workings by this Inſtrument, you muſt have a Care that the Inſtrument be not moved out of its due Place, 'till you have finiſh'd the Work of the preſent Station; for which Purpoſe, caſt your Eye now and then upon your Needle, obſerving whether it continue to hang directly over the ſame Point you ſet it at when you began your Work, and to rectify your Inſtrument if you ſee Cauſe. But becauſe all Tables have not Needles, and where Needles are, they are not accounted over truſty, make uſe of the following Help.

When you have planted your Inſtrument, and made a Point or Prick in your Paper, repreſenting your Station, ſet the fiducial Edge of your Index to it, and turning it ſoftly about 'till you find one remarkable Thing or other upon one Side of the Cloſe, and another on the oppoſite Side, as you look through the Sights of your Index, (which we call Fore-Sight and Back-Sight) draw a remarkable Line with Ink, or rather with a Black-Lead Pen quite over your Paper, which in this Figure is repreſented by the black Line K L; and then, if you ſuſpect that by any accidental Jog, or other Caſualty, the Inſtrument is any thing remov'd, you may eaſily try, and rectify it by applying the fiducial Edge to the ſame Line, and making uſe of Fore-Sights and Back-Sights again upon the ſame Marks which you before obſerv'd upon the oppoſite Sides of the Cloſe.

But if there be no convenient Place for the placing of your Inſtrument, whence you may ſee all the Angles of the Field, more Stations muſt be made uſe of thus:

Fig. 25. Let A B C D E F G H I K L M N be a Field whoſe Angles cannot be all ſeen from any one Angle, or other Place in it. I plant my Inſtrument at the Angle A, and if it have a Needle, I mark what Degree of the Chord it cuts, or turn about the Table on the Head of the Staff, 'till the Needle hang over ſome remarkable Place, (as ſuppoſe the Flower-de-Luce) and ſcrew it faſt; then ſetting up a Stick with a white Paper or Cloath on the Head of it, where I intend my ſecond Station, (as here at Q) I made a Prick or Point in my Paper, to ſignify the Point A upon the Paper on the Table: To which Point I apply the fiducial Edge of the Index, and when I ſee the white at Q, ſo as looking through the Slit I ſee the Thread cut it, I draw the Line O P quite through my Paper with a Black-Lead Pen, and then keeping the fiducial Edge ſtill upon the ſame Point, and turning it round by Degrees, I look at the Angles B C D E F L M N, ſtill drawing dry

Lines with the Points of my Compaſſes, and ſetting on the Meaſures from the Station A, to every Angle meaſur'd to or from, as I did in the laſt Example.

Then I remove the Inſtrument to the Place of of my ſecond Station, having ſet up a Mark at A, and laying the fiducial Edge to the Line O P, I turn about the Table upon the Head of the Staff, 'till through the Slit of the Back-Sight, I ſee the Thread cutting the Mark at A, and then ſcrew it faſt; ſo will my Needle, if a good one, hang directly over the ſame Point that it did at the firſt Station; but however that be, Fore-Sight and Back-Sight will do the Buſineſs; for which Purpoſe it is good to take Back-Marks as well as Fore-Marks at every Station, as was taught in the Example of a ſingle Station, only taking Notice that the Back-Mark, when the Inſtrument is planted in an Angle, muſt needs be out of the Field; as ſuppoſe here at O. But to proceed.

Having meaſur'd the Diſtance between the firſt and ſecond Station, and finding it to be 7, 10, I ſet it upon the Line O P, from A to Q, where I make another Point to repreſent the ſecond Station, and turning about my Index with the fiducial Edge upon that Point, and ſo looking through the Sights at the Angles G H I K, I draw Lines towards them on my Paper, and having meaſur'd between every one of thoſe four Angles, and the Inſtrument, I ſet thoſe Meaſures, as I did the other, with my Scale and Compaſſes, from Q towards every Angle upon his proper Line; and then having the drawn black Bounding-Lines from A to

B, from B to C, and ſo round about the Cloſe, the Protraction is finiſh'd.

But here to make this Figure yet more advantageous, let me (according to my uſual Method) add ſome Advertiſements.

1. Sometimes a Station is ſo taken, that you may meaſure towards two Angles at once, (as here from Q to G and H) in which Caſe you are to ſet down the Chains and Links where the firſt Angle falleth, but ſtill be proceeding to the farther Angle, cauſing the Remainder of the Chains at the Fore-End to advance beyond the former Angles; ſo going on with whole Chains ſo far as you can, to which the odd Links at the End are to be added.

2. If at any of your Stations (as ſuppoſe A) you can ſee an Angle (for Example E) to which you cannot meaſure in a direct Line without paſſing the Boundaries of your Parcel of Land given to be meaſur'd; you may notwithſtandding take in that Angle by a ſtrait meaſur'd Line, as I have done, provided it may be lawfully done without Treſpaſs, and conveniently without troubleſome paſſing of Fences, otherwiſe it muſt be taken from another Station.

3. I here took one of my Stations at an Angle, and the other within the Body of the Field, to ſhew the Variety of Working taught by other Authors, and that 'tis no great Matter where you make your Stations, ſo you can ſee the Angles; elſe it had been full as convenient to have taken my firſt Station alſo within the Body of the Field, as ſuppoſe at R.

4. Though this Figure repreſenteth to your Eye only two Stations, A and Q, your Fancy may multiply them at Pleaſure; for ſuppoſe the Angle H could not have been ſeen from A or Q, how eaſy had it been to have ſet up a Mark at S, and then to have remov'd the Inſtrument thither, obſerving the ſame Directions that were given at the Removal from A to Q?

II. In the ſecond Method the Inſtrument is to be planted twice, or oftner, as Occaſion is, the Rules for Removal of the Inſtrument Fore-Sight and Back-Sight, and meaſuring the Diſtance of Stations, being the ſame as formerly was taught; but inſtead of meaſuring to and from every Angle, we only view each Angle thro' the Sights from two Stations, having apply'd the fiducial Edge to the Points repreſenting thoſe Stations, and having drawn Lines with the Point of the Compaſſes, or a Protracting-Needle, the Interſections repreſent the Angles, from which the Boundary-Lines may be drawn; ſo is the Field protracted. Which that my Reader may underſtand, let him note theſe three Figures.

Fig. 26, 27, 28. Here in theſe three Figures the Angles are mark'd alphabetically, A B C D E F, *&c.* and the Stations by a ſmall Point in a ſmall Circle number'd, 1, 2, or 1, 2, 3, according to their Number and Order.

Fig. 26. The firſt of theſe Figures repreſents the plotting of a Field at two Stations within it, from both which all the Angles may be ſeen.

Fig. 27. The ſecond performs the ſame Work by two Stations taken without the Field, by which Art a Cloſe may be meaſur'd, though the preſent Poſſeſſer will not give us leave to come into it.

Fig. 28. The third ſhews how the Work may be perform'd at three Stations or more, when two ſuch Places cannot be found whence to view all the Angles; which laſt having more of Difficulty than the two former, (tho' indeed not very much) and the Explanation of that will ſufficiently help to the Underſtanding of them, I ſhall a little explicate the Meaning of it in theſe Particulars.

1. From the firſt Station taken according to former Directions, I ſee the Angles A B C D F G K, and accordingly draw Lines upon my Paper towards them from the Point repreſenting that Station, by the fiducial Edge of my Index with the Point of my Compaſſes.

2. Having remov'd my Inſtrument to the ſecond Station, (and in ſo doing, obſerv'd the Rules before given touching ſuch Removals) I thence ſee the Angles ABCDEFGHIK, and draw Lines upon my Paper towards them from the Point repreſenting the ſecond Station. And now viewing my Work, I find upon my Paper Interſections for the Angles A B, D F, G K, but only ſingle Lines toward the Angles C E H I; therefore,

3. Removing the Inſtrument regularly as before, to a third Station, I thence ſee thoſe four Angles C ☞ EHI, and drawing Lines towards them, I have Interſections for them alſo; ſo that having drawn the Lines AB, BC, *&c.* from one Interſection to another, I have the Field perfectly protracted. For theſe Bounding-Lines from Angle to Angle, do not only ſignify the Boundaries of a Piece of

Land given to be meaſur'd, limiting the Figure or Shape thereof, (and are to that Purpoſe given in this and all other Survey-books) but alſo are the true Diſtance by a Scale from Angle to Angle for the Plot upon the Paper; I mean by the ſame Scale by which the ſtationary Diſtances were laid down upon their own Lines. And this holds true in all Kind of true plotting, whether in this Method or any other.

III. The third Method is that of Circuition; and this hath ſeveral Varieties, according to theſe three following Caſes.

1. When the Diſtance from Angle to Angle (without any Exception) is meaſur'd quite round the Plot, either within or without.

2. When the Diſtance is taken only between ſome more notable Angles, and the Perpendiculars of the reſt meaſur'd as you paſs along their Baſes, within the Plot, proper for plain ſolid Ground.

3. When the like is done without the Plot, as in Caſe of plotting thick Woods, Meres, Pools, Bogs, *&c.*

The firſt of theſe are very eaſy, conſiſting in nothing but planting the Inſtrument at every Angle, (either within or without, as Neceſſity and Convenience determine it) obſerving the former Directions for planting and removing the Inſtrument, and alſo for meaſuring the ſtationary Lines on the Ground, and protracting them on the Paper, as is manifeſt in this *Example.*

Fig. 29. Let AECDEF be a Park-pond or Cloſe to be protracted, I firſt plant my Inſtrument at A, and direct the Sights to a Mark in the Angle B, draw-

B, drawing a dry Line from a convenient Point on my Paper towards B, on the Ground, and having meaſur'd by my Chain the Diſtance A B, I ſet it by a Scale upon the correſpondent Line from A to B, drawing a black Line between them with Ink or a Lead-Pen, the Extremities whereof are the Points A and B on my Paper, and the little prick'd Line that goes beyond B, repreſents the Remainder of the dry Line drawn at Random (as to Length) with the Point of the Compaſſes.

Then ſetting up a Mark at A, (if there was none before) I remove the Inſtrument to B, and laying the fiducial Edge to the Line A B, I turn about the Inſtrument upon the Staff, 'till through the Sight I perceive the Thread cutting the Mark at A, and my Needle (if I have one) directly over the ſame Point, that it was when it was planted at A; and ſo ſcrew it faſt.

My next Work is to lay the fiducial Edge to the Point B, and direct the Sights to C, drawing a dry Line towards it, and ſetting the Diſtance B C meaſur'd by the Chain from B to C.

In this Manner I proceed, ſurrounding the Cloſe 'till I come at laſt to A, where I began, by planting the Inſtrument at every Angle, uſing the Help of Back-Sight and my Needle, as I did at B, and then from the Point repreſenting my preſent Station, directing the Sight to the next Angle, as I did from B to C.

In the ſecond Caſe, we do not plant the Inſtrument at every Angle, but at the more conſiderable, taking in the ſmaller by their Perpendiculars from the Baſe as we paſs a long; of which this following Figure may be an Inſtance.

Fig. 30. Let ABCDEFGHIKL be a Cloſe to be meaſur'd; by planting the Inſtrument only at ACF and K, I have the main Subſtance of the Cloſe in the Trapezium ACFK; and for the five ſmall Triangles which muſt be added to the Trapezium, they may be eaſily protracted by the Help of ſuch a little Square as was mention'd towards the latter End of the *Tenth Chapter*; for thereby finding at how many Chains and Links Diſtance from A upon the Ground, the Perpendicular B b falleth upon the Line AC; and having meaſur'd the Length of that Perpendicular, and taken in between my Compaſs-Points of my Scale, I erect a Perpendicular of that Length at b, which is the Point upon the Paper, where ſo many Chains and Links determine, as were meaſur'd upon the Ground, from the Angles A, to the Place where the Perpendicular fell on A c, *viz.* at b. Juſt in the ſame manner I raiſe the other Perpendiculars, D d, and G g, I i, and L l; and then by the Help of the Perpendiculars, I draw (from and to the proper Angles) the Boundary-Lines A B, B C, C D, DE, F G, GH, HI, I K, K L, L A; which, together with the Line E F between the Angles E and F, give the true Plot of the Field in one large Trapezium, and five ſmall Triangles ready for caſting up.

The third Caſe is like the ſecond, that there needeth no new Direction ſo concerning it, but to annex one plain Diagram; all the Difference conſiſting in this, that becauſe we cannot go within it, (being ſuppos'd to be ſome Pool, Bog, or Thicket) we muſt of Neceſſity go on the Outſide, and conſequently all the Triangles made by inward Angles, and their Lines upon the meaſur'd Baſes, muſt be excluded, by the Boundary-Lines, from being any Parts of the Plot, as here is manifeſt

Fig. 31. Suppoſing ABCDEFGHIKLMNO P to be a great Pool, though here be fifteen Angles, I plant my Table only five Times, *viz.* at A E F H and M, and upon the dry Lines A E, F H, H M, and MA, I raiſe their Perpendiculars in due Places, (according to Meaſure) and alſo of a right Height; by which, and my five ſtationary Angles, I draw the Bounding-Lines of the Plot, excluding all the Triangles as foreign to it, they being no Reſemblances of any Part of the Pool, but of Land adjacent,

Where note, 1. That both in this and the former Caſe, ſuch a little Square as I mention'd in the *Second Chapter*, will be very uſeful for ſpeedy raiſing of Perpendiculars; but where the Triangles are very ſmall, it need not be us'd, nor the other mention'd *Chap.* 10.

2. That if by reaſon of troubleſome Bruſh-Wood, Gorſe, or Bogs, *&c.* I could not have meaſur'd cloſe to the Sides E F, H I, or L M, it would be the ſame Thing if I went parallel to them. And this is a Shift that the practical Surveyor will oft be put to make Uſe of, in other Caſes, as well as this.

CHAP.

CHAP. XV.

Concerning the plotting of many Cloſes together, whether the Ground be even or uneven.

THough I deſign not ſo high in this *Manual* as to make my Reader able to ſurvey Lordſhips and Foreſts, much leſs to draw Maps of Countries, but to meaſure a Parcel of Land with Truth and Judgment; yet I would have him ſo expert, as not to be puzzl'd, if any ſhould deſire him to draw (as it were) a true Map of a Tenement or ſmall Demeſn, conſiſting of ſeveral Cloſes; for which Purpoſe, let him that knows no better, obſerve this Method.

Fig. 32. Suppoſe A B C D E F G H I K L M to be a Tenement or ſmall Demeſn, divided into fourteen Cloſes, to be meaſur'd and protracted according to their ſeveral Shapes and Situation. I firſt draw the Plot of the whole by the Method of Circulation, planting mine Inſtrument either at every Angle, or only the moſt conſiderable either within or without, as I find moſt convenient. This being done, a Line from B to M gives the Triangle ABM from the firſt Cloſe. In the next Place I go round the ſecond Cloſe beginning at M, then to B, and ſo about (*cum Sole*) to M again: And then for the third Cloſe, I plant my Table at C, and go round to B, (the Line B C being protracted already) and ſo of all the reſt, ſtill obſerving which are common Lines belonging to ſeveral inward Angles, and their Lines upon the meaſur'd Baſes, muſt be excluded, by the Boundary-Lines, from being any Parts of the Plot, as here is manifeſt

Fig. 31. Suppoſing ABCDEFGHIKLMNO P to be a great Pool, though here be fifteen Angles, I plant my Table only five Times, *viz.* at A E F H and M, and upon the dry Lines A E, F H, H M, and M A, I raiſe their Perpendiculars in due Places, (according to Meaſure) and alſo of a right Height; by which, and my five ſtationary Angles, I draw the Bounding-Lines of the Plot, excluding all the Triangles as foreign to it, they being no Reſemblances of any Part of the Pool, but of Land adjacent,

Where note, 1. That both in this and the former Caſe, ſuch a little Square as I mention'd in the *Second Chapter*, will be very uſeful for ſpeedy raiſing of Perpendiculars; but where the Triangles are very ſmall, it need not be us'd, nor the other mention'd *Chap.* 10.

2. That if by reaſon of troubleſome Bruſh-Wood, Gorſe, or Bogs, &c. I could not have meaſur'd cloſe to the Sides E F, H I, or L M, it would be the ſame Thing if I went parallel to them. And this is a Shift that the practical Surveyor will oft be put to make Uſe of, in other Caſes, as well as this.

CHAP. XV.

Concerning the plotting of many Cloſes together, whether the Ground be even or uneven.

THough I deſign not ſo high in this *Manual* as to make my Reader able to ſurvey Lordſhips and Foreſts, much leſs to draw Maps of Countries, but to meaſure a Parcel of Land with Truth and Judgment; yet I would have him ſo expert, as not to be puzzl'd, if any ſhould deſire him to draw (as it were) a true Map of a Tenement or ſmall Demeſn, conſiſting of ſeveral Cloſes; for which Purpoſe, let him that knows no better, obſerve this Method.

Fig. 32. Suppoſe ABCDEFGHIKLM to be a Tenement or ſmall Demeſn, divided into fourteen Cloſes, to be meaſur'd and protracted according to their ſeveral Shapes and Situation. I firſt draw the Plot of the whole by the Method of Circulation, planting mine Inſtrument either at every Angle, or only the moſt conſiderable either within or without, as I find moſt convenient. This being done, a Line from B to M gives the Triangle ABM from the firſt Cloſe. In the next Place I go round the ſecond Cloſe beginning at M, then to B, and ſo about (*cum Sole*) to M again: And then for the third Cloſe, I plant my Table at C, and go round to B, (the Line BC being protracted already) and ſo of all the reſt, ſtill obſerving which are common Lines belonging to ſeveral Cloſes, (repreſenting the Fences) that I may avoid the Trouble of meaſuring thoſe Lines oftner than once, and lay every Part of every Cloſe in its due Place; and that I be ſure to keep the Inſtrument throughout the whole Work to its true Poſition by Needle, Fore-Sight, and Back-Sight.

There are, I confeſs, divers other ways of doing this Work, but none more ſure or plain, eſpecially if the Ground be uneven; for in that Caſe, i you protract according to the Length of Lines meaſur'd from your Station to the Angles, yo will put your Cloſes into unproportionable Shapes, except you reduce Hypothenuſal Lines to Horizontal, by Inſtruments, or otherwiſe, (which is ſomewhat troubleſome;) and the like may be ſaid when you Plot with the Chain only. Indeed the Method of meaſuring only the ſtationary Diſtances were very proper for ſetting out the Figure of each particular Cloſe, provided the Diſtance of the Stations be large, and taken (if poſſible) upon pretty even Ground, (which ſometimes may b done, tho' moſt of the Cloſe be uneven) and the Work ſo order'd, as not to make too acute Angles; but becauſe this requireth Skill and Care, I rather adviſe my young Artiſt to uſe the circling way, as ordinarily moſt commodious in my poor Judgment, (but not prejudicing other Mens that may differ from me in Opinion) and where need requires, let him obſerve the Directions in the 17th *Chapter*.

☞ But which Way ſoever you go to work there is one very neceſſary Rule to be obſerv'd If the Ground being uneven conſiderably, yo muſt not give up the Content by meaſuring th

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Baſes and Perpendiculars of the Triangles on the Paper by your Scale; but you muſt meaſure the Lines correſpondent to them on the Ground, and caſt up the Content according to that Meaſure. And if it be deſir'd that you ſhould adjoin to your Plot (as is uſual) a Scale of Chains to meaſure Diſtances by, you muſt either by making the Forms of Hills erect and reverſe, or ſome other Note in Writing, mark out your uneven Ground, leaſt thoſe that try it by the Scale, judge your Work erroneous; for though you make that Scale exactly correſpondent to that you protracted by, (as you ought to do) the Hills and Dales in the Ground truly meaſur'd, may make a conſiderable Alteration.

It is convenient when you plant your Table, that the Needle hang juſt over the North-Point of the Compaſs under it in the Box; then may you by the Lines overthwart the Frame of the Table, eaſily draw two Lines quite through the Plot, cutting one another at right Angles, the one pointing at North and South, and the other at Eaſt and Weſt. And if your Skill ſerve you to make the two and thirty Points of the Compaſs upon the Place where they interſect, and to draw the Forms of the Houſes, Woods, and other remarkable Things upon the Demeſn, and the Courſe of Brooks and Rivers running through it, it will add to your Commendation.

And ſo it will alſo, if you take in ſuch Parcels of Land bounding it, whether common or peculiar to other Men, as will make your Plot to look handſomely, like a perfect Square or Oblong. But however that be, you muſt be ſure to protract truly all Lanes going into it, or through it, and all Cloſes of other Mens mix'd with it; and alſo all conſiderable Ponds, Ways, and Out-Lets, with the Names of the Cloſes, and Quality of the Ground, whether Meadow, Paſture, Arable, *&c.*

CHAP. XVI.

Concerning ſhifting of Paper.

IN ſuch Work as that of the laſt *Chapter*, it may ſometimes fall out (through the Multitude and Largneſs of Fields) that one Sheet will not hold your whole Plot; in which Caſe you may help your ſelf by ſhifting Paper (as we call it) thus.

Fig. 33. Let ABCD repreſent our Sheet of Paper that covereth the Table, upon which the Plot of the large Piece of Land EFGHIK ſhould be drawn; having made my firſt Station at E, and the ſecond at F, I find my Paper will not receive the Line F G, but however, I draw ſo far as it will go to the edge of the Paper, and planting my Table again at E, proceed in my Circuition the contrary way to K and I, where I find my ſelf again at a Loſs for my Line I H, but draw it alſo to the edge of the Paper; then with the Point of my Compaſſes ſtriking the Line P O parallel to the edge of the Paper B C, and the Line Q O parallel to D C, and cutting PO in O, I throw aſide for a while, covering the Inſtrument with a new one, which I mark with the Figure (2) for my ſecond Sheet.

Fig. 34.

Fi. 34. Upon which ſecond Sheet (the leading Part whereof is repreſented by the three Lines meeting in the angular Points A and B) I draw P O parallel to A B, the leading edge of the Paper, and croſſing it at right Angles in the Point O, by a parallel to B C, *viz.* the Line O R, being of the ſame Diſtance from B C, that Q O in the former Sheet was from D C; then with a Rule and a ſharp Pen-Knife I cut off the end of the firſt Sheet at the Line PO, and applying the edge of it to the Line PO of the ſecond Sheet, ſo as it may touch that Line all along, and the Line QO of the former touch the Line O R in the latter, ſo as to make one Line with it, I draw the Lines P G, being the Remainder of the Line FG, and the Line OH, being the Remainder of the Line IH, and from their Extremities the Line GH. And if the Plot requir'd it, you might proceed on in the ſecond Sheet, and annex a third and a fourth, *&c.* as there is Occaſion.

These Sheets may be piec'd together with Mouth-Glew or fine Paſte, applying the edge of the former (as you did upon the Table) to the Line PO of the latter.

And note here once for all, that when I ſpeak of applying the edge of the Paper to a Line, I mean the preciſe edge cut by the Line P O; but when I ſpeak of drawing Lines to the edge of the Paper upon the Table, I hope none will think me ſo abſurd as to mean the edge that is couch'd under the Frame, but that my Meaning is, that the Lines muſt be continu'd on the Paper 'till they touch the Frame.

CHAP. XVII.

Concerning the plotting of a Town-Field, where the ſeveral Lands, Butts, or Doles, are very crooked: With a Note concerning hypothenuſal, or ſloaping Boundaries, common to this and the fifteenth Chapter.

Fig. 35. SUppoſe ABCDE divided, in the manner of a common Field, into ſeven Parts or Doles, belonging to ſeven ſeveral Men: Firſt, plot the whole, as before hath been taught, then meaſuring from A to B upon the Land, ſet one Note down (as you go along) at how many Chains or Links (or both) the Diviſion is between Dole and Dole, and accordingly mark them out by the Help of Scale and Compaſſes in the Line A B on the Paper-Plot. In the very ſame Manner you muſt meaſure and mark out the Lines O C and E D; which being done, take the Paper of the Inſtrument, and laying it before you on a Table, with the Side A E towards you; the Compaſſes muſt be ſo open'd and plac'd, (as by a few Tryals they may) that one Foot reſting upon the Table, the other may paſs through the Points of Diviſion upon all the three Lines, *viz.* A B, O C, and E D, as in this Figure they do.

If the Content of any one or more of theſe Parts, Butts, or Doles, be deſir'd without plotting, it may eaſily be done, without your plain Table, thus: Take the Breadth by your Chain at the Head, Middle, and lower End, and adding theſe Numbers together, the third Part of their Sum is the equated Breadth; by which, multiplying the Length meaſur'd down the Ridge, (or Middle) the Product gives the Content.

But both in this Caſe, and that mention'd in the 15th *Chapter*, the Figure of a Plot may be ſomewhat diſorder'd, not only by the Unevenneſs of the Ground within, for which I have given due Caution already, (that being both the more common and more conſiderable Caſe) but alſo by the great Declivity of the Ground where the boundary Lines go, either of the whole Plot, or particular Parcels. For whereas in plotting, every Line is preſum'd to be Horizontal, (or level) that it may paſs from Angle to Angle the ſhorteſt Way, and that every Part may be duly ſituated, and none thruſt another out of its right Place, if it be not level, but falling down towards a Valley, or riſing up Hill, or compounded of both, a Line over ſuch Ground, (though true for the Meaſure, and for giving up the Content) will be falſe as to the Plot, and therefore muſt be reduc'd to a Level, and ſo taken off the Scale, and protracted. For the doing of this, there are ſeveral Inſtruments very proper, eſpecially Mr. *Rathburne*'s Quadrant upon the Head of his Peracter, (though it were better to have a Semi-circle, than a Quadrant ſo plac'd) and divers others. But ſuppoſe my Country Friend to have no other but ſuch as I have already deſcrib'd, I ſhall ſhew him a plain eaſy Way much us'd by practical Surveyors, eſpecially in *Ireland*, as ſome of themſelves have told me, being the very ſame that he may meet with in Mr. *Leybourne*'s Book, intitul'd, *The Compleat Surveyor*; I mean the ſecond Way by him diſcover'd.

Fig. 36. Suppoſe A B C to be part of a Hill falling within my Plot, my boundary Line going crookedly from A to B, following the Surface of the Ground. To find the Horizontal Line, (equal to A C) I cauſe one to ſtand at the Point A, (the Foot of the Hill) and to hold up the End of the Chain to a convenient Height, and gently aſcending the Hill, I draw it level, and make a Mark where it toucheth the Hill, obſerving the Number of Links betwixt my Aſſiſtant's Hand, and that Place where he muſt take his ſecond Standing, and hold it up as before, and ſo I draw it out level again, 'till it touch the Place where he muſt take his third Standing, noting the Links as before, and ſo proceed, 'till at laſt, from his fifth Standing, I draw the Chain level to the higheſt Point within my Plot, *viz*. the Point B. And now as the prick'd Lines of this Figure put together, are evidently equal to the Line A C, ſo are the Links noted down at every Station, when ſum'd up, equal to the Horizontal Line of that Part of the Hill.

In the very ſame Manner, only inverting the Order, you may find the Horizontal Lines going down Hill, where that is moſt convenient: And if their be both Aſcents and Deſcents in one Line betwixt two Angles, the Horizontal Lines of both muſt be found and join'd together in Protraction.

All this concerning Declivities of riſing or falling Ground, is to be underſtood when they are conſiderable, and a very exact Plot requir'd; for ſmall ones, eſpecially when much Exactneſs is not expected, are not regardable.

CHAP. XVIII.

Concerning Plotting a Piece of Ground by the Degrees upon the Frame of the plain Table ſeveral Ways, and Protracting the ſame.

Hitherto I have ſhewn the Uſe of the plain Table as ſuch, and I think my Directions have been near as plain as the Inſtrument it ſelf: At which ſome quarrel for its Over-plainneſs, expoſing the Art to proud ignorant People, who judging the reſt of the Surveyor's Work to be as eaſy as looking through Sights at a Mark, and drawing Lines by a Rule, are apt to undertake to Uſe it, or ſlight the Skill of ſuch as do. Others ſay, (and that truly) that for vaſt Things, ſuch as Foreſts, Chaſes, &c. the Circumferentor is more proper: And every one muſt grant, that in wet Weather, either that a Peracter, a Theodolite, or Semi-circle, muſt needs be better than the plain Table cover'd with the Paper, which cannot endure Wet. Hence it is, that ſome Artiſts have to good Purpoſe ſhew'd how the Box ſcrew'd to the Index, and that made to turn on the Head of the three-legg'd Staff, become a Circumferentor. And if theſe thus ſix'd be turn'd about upon the Center of the Table, they will (ſay ſome with good Reaſon, Mr. *Leybourn* for one) perform the

Work of the Peractor, much better than the Peracter it ſelf. Others ſhew, (as I ſhall briefly) that taking the Inſtrument as it is without the Charge of farther fitting it, or trouble of removing the Box, the Index turn'd upon the Center, will, by Help of the Degrees on the Frame, perform the Work of the Theodolite, to which the Semi-circle is near of Kin.

And though I might eaſily anſwer all theſe Objections, by ſaying the firſt is frivolous, ſuch fooliſh Arrogance being eaſily contemn'd or check'd (if worth the While) by putting ſuch conceited Fools upon the harder Part of the Work. The ſecond impertinent to our Purpoſe, who deſign not to plot ſuch vaſt Parcels of Land: And the third concerning only an extraordinary Caſe, and that well provided for otherwiſe; for ſure no Man that hath not a Body of the ſame Metal with his Inſtruments, will ordinarily meaſure Land in continual Rain, (a ſudden Shower may be fenc'd againſt by a Cover;) and if any be ſo eager upon his Work, I have ſhewn how it may be done in the former Chapters of this Book, without planting any Inſtrument at all, by Chain, Scale, and Compaſſes alone: Yet I ſhall ſhew how the Plot of a Field may be taken by the Degrees on the Frame, not every Way that I could imagine, nor that I could tranſcribe, (for that would be tedious) but two Ways only, whereof the one is proper for an ordinary Cloſe, where all the Angles may be ſeen from one Station within it, the other fitting any Parcel of Land, though much larger, whatever be the Figure of it.

For the former, take this Example.

Fig. 37. Let A B C D E repreſent the Figure of a Field to be plotted by the plain Table in rainy Weather. I put on the Frame without a Paper, the graduated Side upwards, and plant it in ſome convenient Place, whence I can ſee all the Angles as at O; then placing the Index upon the Table, ſo as the fiducial Edge do at the ſame Time go through the Center upon the Table, and the Lines upon the Frame of the Table cutting it perpendicularly at 360, (where the Degrees begin and end) and 180, (the exact half) I turn about the Table upon the Staff-Head, 'till through the Sights (the Side mark'd with 180 being next my Eye) I ſee the Angle A, and then ſcrew it faſt, obſerving where my Needle cutteth, and by back Sight cauſing a Mark to be ſet up in the Line C D at the Point F, that the Inſtrument may be kept firm from moving (or be rectify'd if it be mov'd) during the Work. And now the Line A O F paſſing upon the Land from the Angle A, directly under the Sights of the Inſtrument to the Mark at F, is (as it were) the prime Diameter whence the Degrees of the Angles are to be number'd, and accordingly I mark the Angle A in my Table hereafter to be exemplify'd with 360 Degrees. But to proceed, turning my Index with the fiducial Edge upon the Center, 'till I ſee the Thread cutting the Mark at B, the ſaid Edge cuts upon the Frame at 76 Deg. 15 Min. which I note down for that Angle: The like Work I do, turning the Sights to C D and D, (but not to F, for there is no Angle, but only a Mark in the Boundary) and I find my Index to cut for every Angle as I have mark'd them within the prick'd Circle of the laſt Figure, *viz.* 157 Deg. 35 Min. for C; 225 Deg. 20 Min. for D, and 278 Deg. and 50 Min. for E.

Then I meaſure (or cauſe to be ſtrictly meaſur'd by others) the Diſtances betwixt the Place where the Inſtrument ſtands, and every Angle, and find them to be as I have ſet them upon the prick'd Lines in the little Circle, *viz.* A 4 Chains 20 Links, B 4 Chains 3 Links, C 3 Chains 84 Links, D 5 Chains 35 Links, E 5 Chains 6 Links. And now my Table both for Lines and Angles is thus perfected, and the Work is ready for Protraction within Doors.

	D	M	C	L
A	360	00	4	20
B	76	15	4	03
C	157	35	3	84
D	225	20	5	35
E	278	50	6	06

Your Judgment will eaſily inform you, that in ſuch Weather we ſhall hardly ſtand to make our Table neat and formal, but any thing (how rude ſoever) that we can underſtand, doth the Feat. A *Welſh* Slate with a ſharp Stile, (or for want thereof, a Black-Lead Pen and a ſmooth End of an hard Board like a Trencher) is more convenient at ſuch a Seaſon, than Pen, Ink, and Paper. But of all, I ☞ would commend for Expedition a Read-Lead Pen, whereby you may mark out every Angle neatly with one Touch upon the Table it ſelf, juſt where it toucheth the Frame by Help of the fiducial Edge, and cloſe by it the Length of the Line from the Center to that Angle: All which may be eaſily clear'd off by a wet Spunge or Cloath ſo ſoon as you have protracted. Or, if through the Spongineſs of the Wood, the Head of the Table (which we uſe to cover with Paper) were made a little reddiſh, what great Harm were that? We are forc'd to do it more real Wrong by the Points of the Compaſſes in the ordinary Way.

Fig. 37. Now to protract our Obſervation, I draw upon a Paper the Line AF at Adventure, ſo it be long enough, and ſtick a Pin in it at pleaſure for the Center O, upon which I place the Center of the Protractor, ſo as the ſtraight Side (or Diameter) of the Protractor may juſt lie upon the Line AF, the Limb or Arch-Side being upwards towards B; by Help whereof I make a Prick or Point on my Paper at 76 Deg. 15 Min. for B, and at 157 Deg. 35. Min. for C, according to the Number neareſt to the Limb.

Then turning the Protractor about on the Pin with the Arch or Limb down towards D and E, 'till the Diameter lie again juſt upon the Line AF, I number downwards from the right Hand towards the left, by that Rank of Figures that are nearer to the Center, beginning 190, 200, *&c.* and over againſt the Places where 225 Deg. 20 Min. and 278 Deg. 50 Min. fall, I prick the Paper at the Side of the Limb, and through thoſe four Points I draw ſo many ſeveral Lines, (having laid aſide the Protractor) upon which, and alſo upon the Line AO, I mark out by Points the true Meaſure of every Line (by a Scale) from the Center, and from thoſe Points drawing the Lines AB, BC, CD, DE, and EA, I have the true Plot of a Field.

Where note, by the Way, that we eſtimate Minutes, as well as we can, both upon the Frame of the plain Table, and the Protractor, accounting half a Degree 30 Minutes; third Part 20; a fourth Part 15, *&c.* And though by this Means it is impoſſible to avoid ſmall Errors, 'tis eaſy to avoid ſenſible ones: And the like may be ſaid when we protract by a Line of Chords, of which I now come to treat.

Having proceeded in the Field as before, and made my Table for Lines and Angles, or done that which is equivalent by a Red-Lead Pen, I draw the Line A F, and having extended my Compaſſes to the Radius (or 60 Degrees) on a Line of Chords, I ſet one Foot towards the Middle of the Line A F, and with the other I deſcribe a Circle like that in this Figure of a five-angl'd Field, but much larger, according to the Length of the Radius: Then extending the Compaſſes from the Beginning of the Line, to 76 Deg. 15 Min. I ſet one Foot in the Interſection of the Circle by the Line A, and with the other Foot make a Mark in the Circumference of the Circle upwards, towards the right Hand, and through it draw the dry Line B O.

In the next place I ſubſtract the Angle 76. 15 from 157. 35, where the Index cut for the Angle C, and there reſteth 81 Deg. 20 Min. which I take off the Line as before, and ſet it upon the Circumference from the Interſection by B O, toward the End of the Diameter mark'd with F, and through the Point where it falleth, draw the dry Line C O.

In like Manner I ſubſtract 157 Deg. 35 Min. from 225 Deg. 20 Min. and the Difference is 67 Deg. 45 Min. which I ſet from the Interſection by the Line CO, downwards paſt the prime Diameter AF, and through the Point where it falleth, draw the Line DO.

Laſtly, having ſubſtracted 225 Deg. 20 Min. from 278 Deg. 50 Min. there reſteth 53 Deg. 30 Min. which muſt be ſet downward towards the left-Hand from the Interſection by DO; and through the Point where that falleth, I draw the Line EO. And now when I have ſet the particular Meaſures upon every Line, and drawn the boundary Lines, as I muſt have done if I had us'd a Protractor, the Plot is finiſh'd.

But for better Aſſurance that I have done my Work well, I take the Meaſure of the remaining Angle AOE upon its proper Arch, *viz.* from the Interſection of the Circumference by AF, to the Interſection by EO, and applying it to the Line of Chords, I find it to be 81 Deg. 10 Min. as it ought to be, for it ſhould be the Complement of 276 Deg. 50 Min. to 360, and ſo it is.

And for farther Satisfaction, I ſum up the Degrees and Minutes of all the five Angles, which for Plainneſs ſake I have noted in every one of them on the outſide of the Circle in the Figure ſo often referr'd to, and their Sum is 360, as it ought to be, and as here is evident.

76. 15
81. 20
67. 45
53. 30
81. 10
———
360. 00

My Reader may now expect that I teach him how to take a Plot at two or more Stations, when all the Angles cannot be ſeen from one: But becauſe this is ſo eaſy from the Grounds already laid, to any that is ingenious, and in part render'd unneceſſary by the Method preſently following, I ſhall content my ſelf to give this general Hint.

When you have from one Station taken in all the Angles you can ſee from thence, and then are to remove to your ſecond Station, do juſt as you would do if the Table were cover'd with a Paper; only it is at your Choice, whether you would guide your ſelf for Back-ſight by a Line that may be rubb'd off, drawn upon the Table it ſelf, from the Center to the Degrees, on the Frame along the fiducial Edge, or by noting only what Degrees it cuts on either Side of the Center, the Edge paſſing through it, that by the Help thereof and the Needle, the Inſtrument may be plac'd in the ſame Line and Situation as before, for taking in the reſt of the Angles, if it can be, if not, another Station muſt be taken after the ſame Manner. But now to my ſecond Method.

Fig. 38. Let ABCDE be the Figure of a Field to be plotted, the Weather being bad, I ſend my Aſſiſtants to find the Length of every Side, meaſuring it about, *cum Sole*, beginning at A, who return me ſuch an Account of every Side, in Chains and Links, as I have noted them upon the Figure, and in the Table following, *viz.* AB 3 Chains 73 Links, BC 4 Chains 91 Links, *&c.* In the mean Seaſon, I make haſte to find the Angles, and without Curioſity plant the Inſtrument at B, and laying the Index on the Center I look at C, and find the Index cutting 10 Deg. 15 Min. and looking at A, it cuts 126 Deg. 45 Min. out of which if I ſubſtract 10 Deg. 15 Min. there reſtthe 116 Deg. 30 Min. for the Angle A; but becauſe I like not my Quarters ſo well as to ſubſtract there, I ſet them down thus: $\mathrm{B}^{\mathrm{A}\;126.\;45}_{\mathrm{C}\;\;10.\;15}$ the Meaning whereof is, that B notes the Angle, and C A the Lines meeting there, cutting ſuch Degrees on the Frame; and the Reaſon why I ſet A above, is for more ready ſubſtracting afterwards; then removing to the Angle C, and thence looking at B and D, I find the Index to cut as is here expreſs'd, $\mathrm{C}^{\mathrm{B}\;153.\;10.}_{\mathrm{D}\;\;15.\;40.}$

In like Manner I find at D thus, $\mathrm{D}^{\mathrm{C}\;96.\;05}_{\mathrm{E}\;28.\;50}$

At E thus, $\mathrm{E}^{\mathrm{D}\;141.\;20.}_{\mathrm{A}\;\;11.\;45.}$

And laſtly, at A I find them thus, $\mathrm{A}^{\mathrm{E}\;98.\;30}_{\mathrm{B}.\;\;9.\;20}$

This being done, I haſte under Covert, and by Subſtraction find 116 Deg. 30 Min. for the Angle B, 137 Deg. 30 Min. for C. 67 Deg. 15 Min. for D. 129 Deg. 35 Min. for E, and 89 Deg. 10 Min. for A, as you find them on the Figure, and in this Table together with the Length of the Lines.

An.	*D.*	*M*	*Side.*	*Ch.*	*L.*
A	89	10	A B	3	73
B	116	30	B C	1	91
C	137	30	C D	4	88
D	67	15	D E	9	64
E	129	35	E A	2	29

Note, that there is a Way to find the Angles without Subſtraction, if at every Station you lay the fiducial Edge over the Center, and the Diviſions 180 and 360, turning about the Head of the

Inſtrument upon the Staff, 'till through the Sights you ſee one of the neighbouring Angles, for the Index turn'd upon the Center to the other Angle, will give you the Quantity of the Angle you are at, but this exact planting at every Angle is more tedious than the other, and therefore not ſo fit for wet Weather. But now to protract this Plot :

Firſt, by my Scale, Rule, and Compaſſes, I draw the Line A B in Length 3 Chains 73 Links, ending at the Point B ; then laying the Center of my Protractor upon the Line A B, ſo as the Center of it be upon the Point A, and that end of the Diameter from which the Numbers are reckon'd on the Arch or Limb towards B, I make a Point for the Angle A at 89 Deg. 10 Min. by the Guidance whereof, and the Point A, I draw the Line A E, which according to my Scale, muſt be 2 Chains 29 Links.

In like Manner placing the Diameter upon A E, juſt as it was upon A B, and the Center upon the Point E, I mark out by the Limb (for the Angle E) 129 Deg. 20 Min. by which I draw the Line E D, 6 Chains 64 Links.

In the next Place, I bring the Center of the Protractor to the Point D, its Diameter lying on the Line E D, and its Limb towards A, by which I prick out 67 Deg. 15 Min. for the Angle at D, and draw the Line 1 Chain 88 Links.

Laſtly, the Center being at C, and the Diameter upon the Line D C, in ſuch Manner as before at other Angles, I prick out by the Limb or Arch 137 Deg. 30 Min. and draw the Line C B, ſo that at B my Plot ſhould cloſe ; and if rightly done, the Angle at B will be 116 Deg. 30 Min. and the Side B C 4 Chains 91 Links, which by Meaſure I find ſo to be.

But if I plot by a Line of Chords, I am not bound to this Order, but may go from A to B, and ſo round that Way if I pleaſe, which I could not ſo well do with a Protractor, without reckoning my Numbers backward, yet it muſt be granted that a Line of Chords neither doth the Work ſo quickly nor conveniently, for this is the Way.

When I have drawn the Line A B of a right Length, I ſet the Compaſſes to the Radius, and placing one Foot of the Compaſſes in the Point B, and with the other deſcribe an Arch of a competent Length, beginning at that Side of the Line A B that is deſign'd not to be the inward Side, and upon this Arch, 116 Deg. 30 Min. muſt be ſet; but becauſe my Line of Chords gives me only 90, I ſet them firſt on from the Line A B, and then take off the Remainder 26 Deg. 30 Min. I join them to the 90 upon the Arch, making a Point, through which the Line B muſt be drawn of a due Length. In the like Manner muſt I do at C E, but the Angles at A and D need no ſuch piecing, being capable of being meaſur'd out by a Line of Chords at once.

Nor do your Angles only give you Trouble in this Kind of Work, but oft-times your Lines will be found too ſhort to receive the Touch of an Arch upon the Radius, eſpecially if the Line of Chords be large, and your Scale little; and ſo it may often fall out when you uſe the Protractor upon ſuch ſhort Lines as A E and C D of this laſt Figure: In which Caſe a Rule muſt be apply’d to them, and they muſt be extended to a due Length, that the Arches may meet them without the Figure. And if thoſe Extenſions of Lines, and deſcribing of Arches, ſpoil the Beauty of your Plot, the Matter is not weighty, ’tis ſo eaſy to be retriev’d ; for if you lay on a clean Paper, and prick thro’ every Angle, Lines drawn between thoſe Points, will give you the Plot neat and perfect.

One Thing more before I cloſe this long Chapter. The Artiſt ſometime loſeth his Labour of Protraction through ſome Error in the Field, ſo as his Plot will not cloſe ; ’tis therefore good to know, before you begin that Work, whether it will or no ; for which Purpoſe if we take a Number leſs by two than the Number of Angles in the Plot, and thereby multiply 180, that Product being found to be equal to all the Angles, the Plot will cloſe, and ſo it appears by our Plot in this preſent Work ; the Multiplier being 3, becauſe the Angles are 5, and the Multiplier muſt be two leſs than the Number of Angles.

	Deg.	Min.
180	89	10
3	116	30
———	137	30
540	67	15
	129	35
	———	
	540	

This Kind of Tryal is grounded upon two Principles of *Euclid* and *Ramus*, mention’d in the firſt and third Chapters of this Book, ſhewing that in all plain Triangles, all the Angles taken together are equal to two right Angles, and that the Sides (conſequently the Angle alſo) of every triangle Figure, are more by two than the Triangles of which it conſiſteth: But I think it not proper to be large in ſuch Things, whereof my young Artiſt is like to make but little Uſe; for when all is done, I confeſs, with Mr. *Wing* in his *Art of Surveying*, *Lib.* 6. *Chap.* 15. that this Way of plotting by the Degrees, is far more troubleſome, tedious, and liable to Error, than the other Ways upon a Sheet of Paper; and therefore not ordinarily to be us'd, but when Neceſſity compelleth us.

CHAP. XIX.

Concerning taking in acceſſible Diſtances by the plain Table, and acceſſible Altitudes by the Protractor.

Fig. 39. THE Subſtance of what is to be ſaid for the firſt of theſe, is gather'd from the Inſtructions given for plotting a Field, by meaſuring only the ſtationary Diſtance; but to make the Caſe more plain to an ordinary Capacity, ſuppoſe the Line A C to be the unknown Breadth of a River, over which a Bridge of Boats is to be laid, and the General (that he may inform himſelf what Store of Boats and

Planks is neceſſary to be brought down) commands me to tell him the true Diſtance from A where he is at preſent, to C a little Boat-houſe on the other Side the Water.

To ſatisfy his Demand, I plant my Table cover'd with a Paper at A, cauſing one to ſet me up a Mark at B, at a good Diſtance from me, along the Bank of the River, (the farther the better, if Diſtance do not hinder Sight :) Then having choſen a Point to repreſent A, and laid the fiducial Edge upon it, I direct my Sights towards C and B, and ſtrike Lines towards them. Which done, I ſet up a Mark at A, and from thence meaſure to B, (6 Chains 32 Links) and ſo plant my Inſtrument at B, laying the fiducial Edge to the Line A B, and turning about the Head of the Inſtrument upon the Staff, 'till through the Sights I Spy the Mark at A, and then ſcrew it faſt.

In the laſt place, I take 6 Chains 32 Links off my Scale. and ſet it on the Line A B, from A to B, and laying the fiducial Edge to the Point B, from thence direct the Sights to C, and draw the Line B C, meeting or cutting the Line A C in C : So ſhall the Space A C meaſur'd on the Scale (*viz.* 8 Chains 29 Links) be the Diſtance deſir'd, and becauſe the Chain is 22 Yards long, if I multiply 8.29 by 22, the Product is 182 Yards and ,$\frac{38}{100}$ of a Yard, which by Reduction is ſome little more than 13 Inches and $\frac{3}{5}$ of an Inch.

Now, to take the Height of a Tree, Tower, or Steeple by a Protractor, without any Arithmetical Operation, hang a Plummet with a fine Silk Thread at the Center of it, and hold it ſtedfaſtly with that end to your Eye, where the Numbers begin, then look ſtrait along the Diameter, as if you were to ſhoot in a Croſs-Bow without a Sight, (ſtill removing backward and forward as there is Occaſion) 'till you ſee the top of the Tree, Tower, or Steeple, and the Thread at the ſame Time fall upon 45 Deg. ſo ſhall the Diſtance from your Eye to the Tree, Tower, or Steeple, meaſur'd in an Horizontal or level Line, together with the Height of your Eye above the bottom of it, be equal to the Height thereof.

If either for Convenience of Sight, or any other Reaſon, you think good to ſet the other end of the Diameter to your Eye, then the Thread for the Trial aforeſaid muſt fall upon 135 Deg. inſtead of 45. Other ways of doing this Work by this Inſtrument (or a Quadrant) with the Help of Trigonometry, and by other Inſtruments, I forbear at preſent, ('till I write a ſecond Part) conſidering whoſe Benefit is here intended.

CHAP. XX.

Of caſting up the Content of Land by a Table.

TO make up the Number of my Chapters to an even Socre, I ſhall add one at the Deſire of my worthy Friend Mr. *S. L.* before mention'd, (to whoſe Experience and Communicativeneſs I acknowledge my Self indebted for the Notion of meaſuring crooked Land or Doles at the Middle and both Ends, marking every where how the

Diviſions fall, as is mention'd in the beginning of *Chapter* 17.) concerning the Uſe of a *Table* borrow'd out of the 46th *Chapter* of Mr. *Leybourn's Compleat Surveyor*, ſecond *Edition*, *Page* 271, which with the Uſe take as followeth.

Links	R.	P.
100000	4	00
90000	3	24
80000	3	08
70000	2	32
60000	2	16
50000	2	00
40000	1	24
30000	1	08
20000	0	32
10000	0	16
8750	0	14
8125	0	13
7500	0	12
6875	0	11
6250	0	10
5625	0	09
5000	0	08
4375	0	07
3750	0	06
3125	0	05
2500	0	04
1875	0	03
1250	0	02
625	0	01

This *Table* conſiſts of three *Columns*, the firſt containing *Links*, the ſecond *Roods*, (or *Quarters of Acres*) the third *Perches*; and the Uſe of it is thus:

Suppoſe a Field to be 7 Chains and 25 Links long, and 5 Chains 50 Links broad, theſe by Multiplication make 398750, (as here is evident) whereof 5 Figures being cut off towards the right Hand, the Figure 3 ſignifies Acres, and the reſt, *viz.* 98750 denote Parts; and to reduce them into Roods and Perches, I firſt ſubſtract from 98750 the greateſt Number of Links in my *Table* that can be ſubſtracted from it, *viz.* 90000, (and put down for it 3 Roods 24 Perches, which I find over againſt it in the

```
    7.25
    5.50
 -------
   36250
  3625
 3625
 -------
 3.98750

 A R P
 -------
 3 3 24
      14
 -------
 3.3.38
```

the annex'd *Columns)* and the Remain being 8750, I look in the *Table*, and find over againſt it 14 Perches, which by Addition makes 3 Roods 38 Perches; ſo is the whole Content of the Field 3 Acres, 3 Roods, 38 Perches.

But note here, that if the Remainder after the firſt Subſtraction cannot be found in the *Table*, you may take the neareſt to it, ſo the Error will be but part of a Perch.

As for Example.

7.35 being the half Perpendicular, and 9.23 the Baſe, give for their Product 6.78405. The 6 ſignifies Acres, and from the reſt 70000 being ſubducted, (to which 2 Roods 32 Perches anſwer) there reſteth 8405; which, becauſe I cannot find in my *Table*, I take the neareſt, which is 8125, to which 13 Perches anſwer; ſo the whole Content of that triangular Cloſe, is 6 Acres, 3 Roods, and 5 ſquare Perches, and a little better.

A	R	P
6	2	32
		13
6	3	05

But *Manum de Tabula* ———

I am at preſent taking Leave of my Countryman; and ſuppoſing he brought with him any competent Stock of natural Capacity, and ſo much Arithmetick as enabl'd him to add, ſubſtract, multiply, and divide, I dare make him judge, after he hath as faithfully labour'd to underſtand me, as I to be underſtood, whether I have not perform'd what I undertook in my Title, or elſewhere.

FINIS.

ADVERTISEMENT.

THE Author hereof uſeth in *Winter* and *Spring* Seaſons to [illegible] young Gentlemen, and others, at his Habitation near *Dunham* in *Cheſhire*, and to inſtruct them in theſe Parts of the *Mathematicks*, viz.

- *Arithmetick.*
  - Vulgar concerning
    - *Whole Numbers,*
    - *Fractions,*
    - *Ballancing Accounts.*
  - Artificial by
    - *Decimals,*
    - *Logarithms,*
    - *Inſtruments,*
    - *Symbols, or Algebra.*
- *Geometry*, and therein
  - *The Doctrine of plain Triangles.*
  - *Meaſuring Superficials, and particularly Land, by all uſual Inſtruments.*
  - *Meaſuring of ſolid Bodies.*
  - *Gauging of Caſks.*

The *Doctrine* and Uſe of *Globes*, and *Spherical Triangles.*

The Principles of *Aſtronomy* and *Navigation.*

The Art of *Dialling*, by *Logarithms*, *Scales*, and *Geometrical Projection*, &c.

Vivat Regina.

Floreat Regnum.

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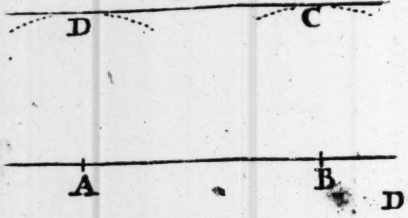

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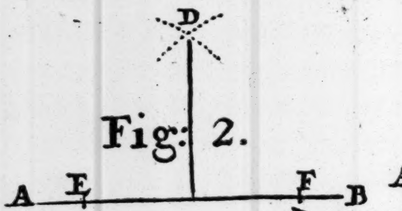

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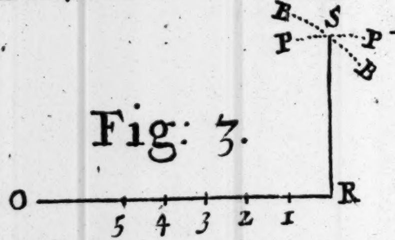

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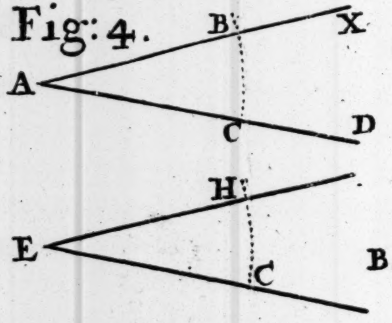

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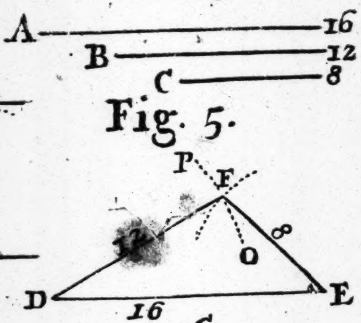

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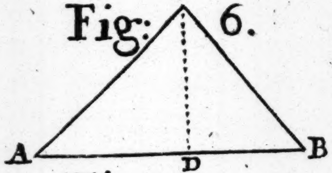

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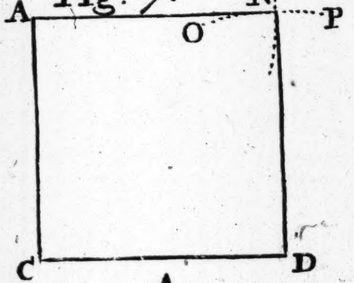

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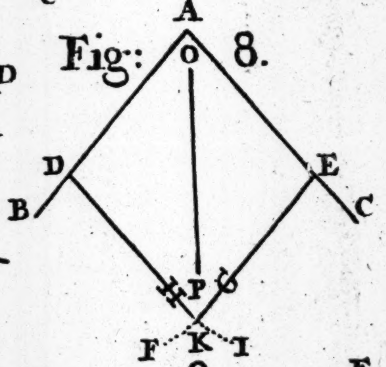

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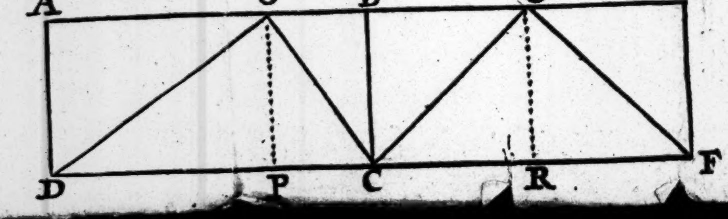

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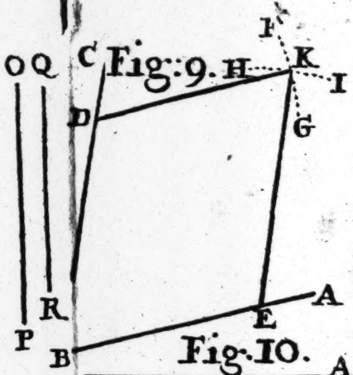

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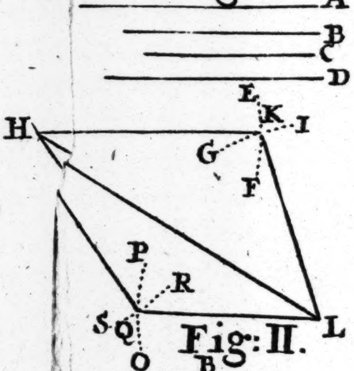

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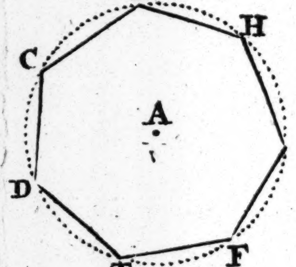

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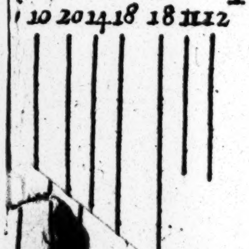

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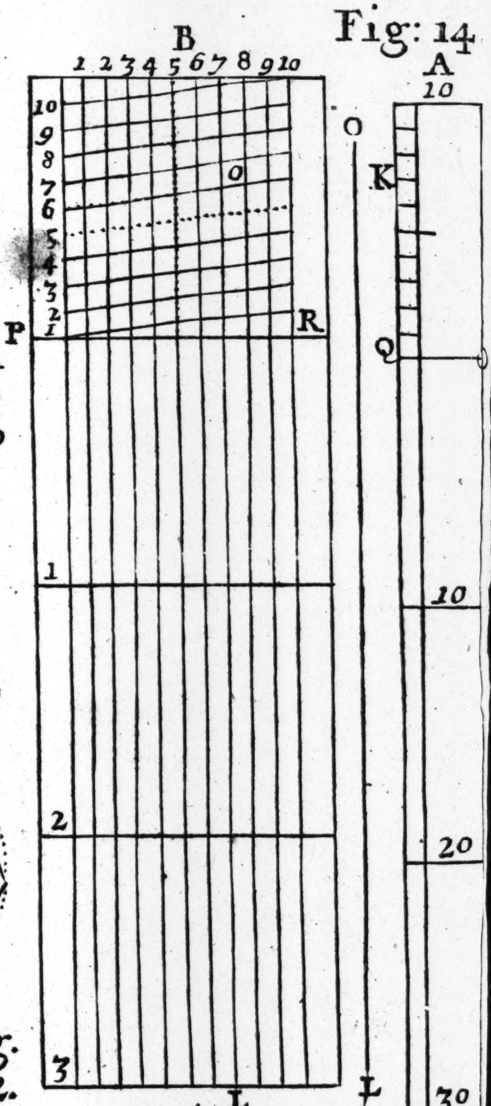

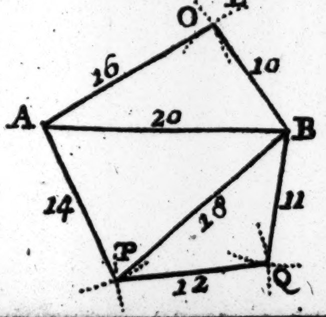

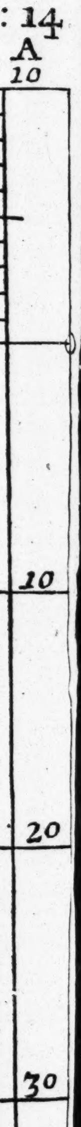
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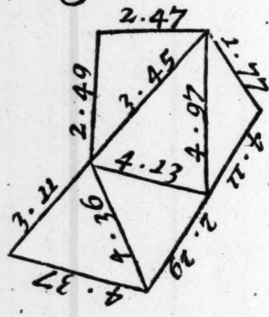
Fig: 18



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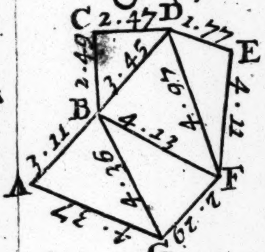

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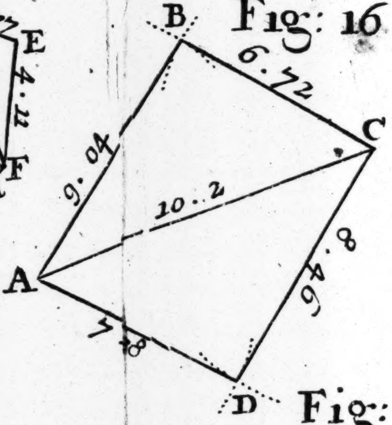

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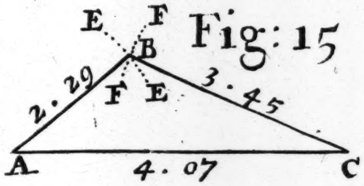

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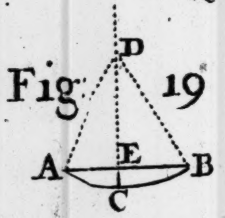

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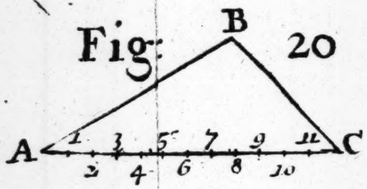

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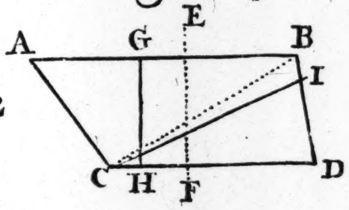

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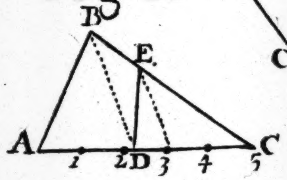

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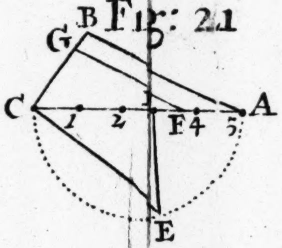

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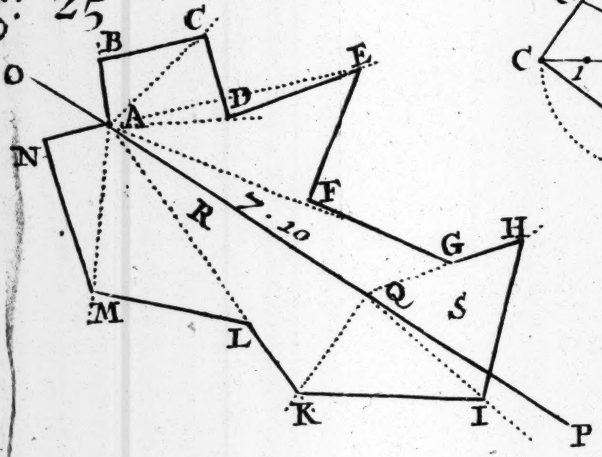

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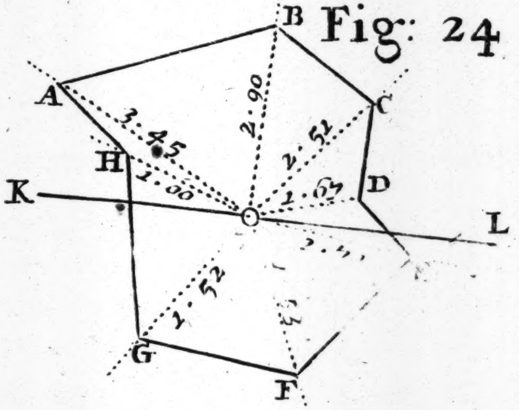

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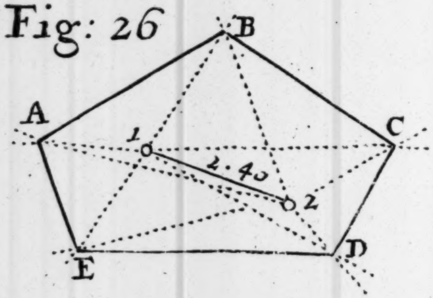
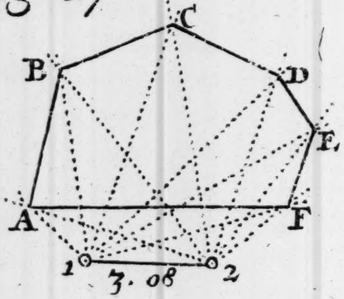


Fig: 27



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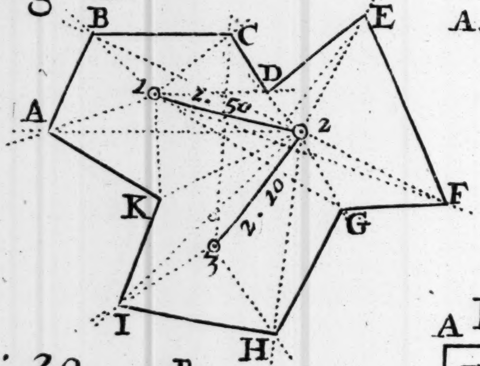

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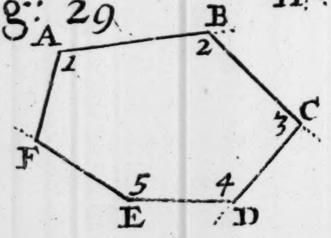

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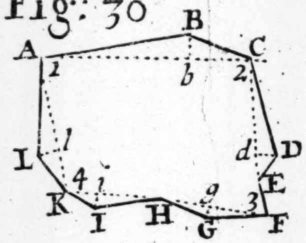


Fig: 31

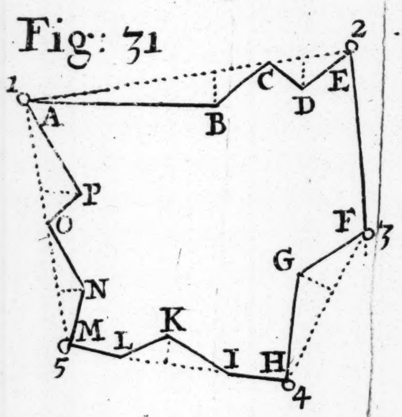
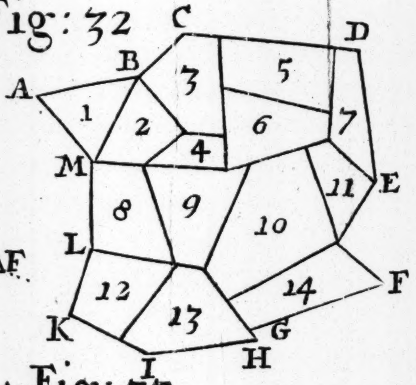


Fig: 32



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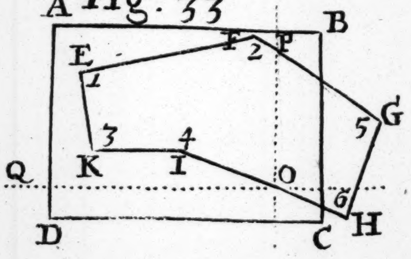

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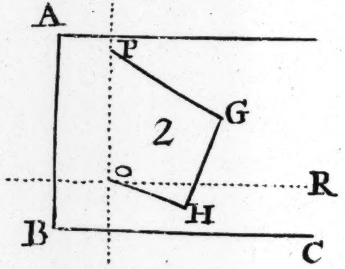

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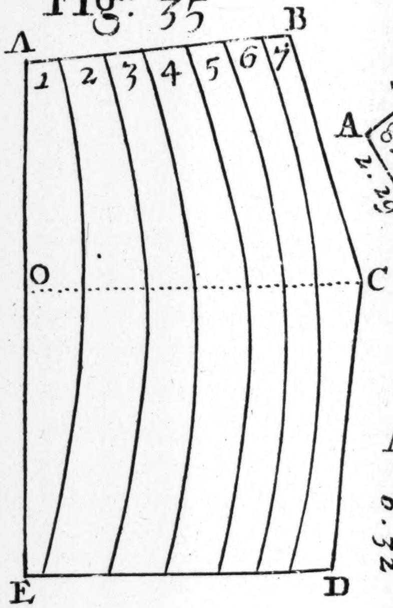

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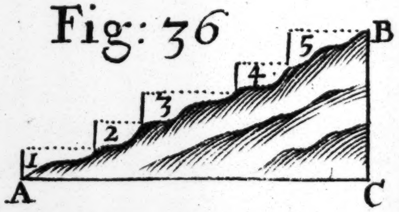

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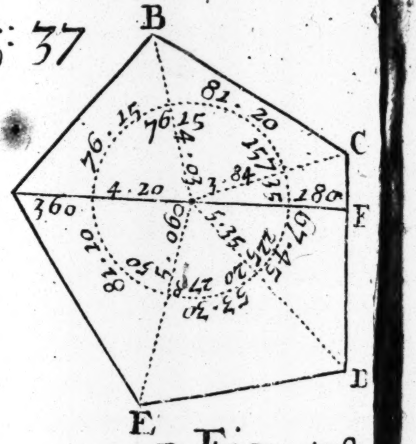

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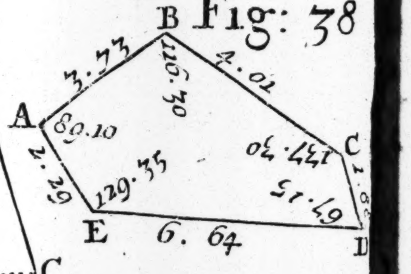

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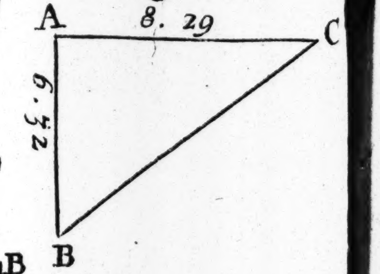

AN

APPENDIX,

CONTAINING

Twelve PROBLEMS,

TOUCHING

Compound-Intereſt and Annnities.

BEING

Part of a LETTER ſent by the
Author, to his worthy Friend Mr.
John Collins, Fellow of the *Royal
Society.*

Together with

A quick and eaſy Method to contract the Works of Fellowſhip and Alligation alternate.

LONDON,

Printed in the Year 1710.

Twelve Problems,

TOUCHING

Compound-Intereſt and Annuities, expreſs'd in Symbols, *to be reſolved by* Logarithms, *firſt preſented, in twelve ſhort Lines, to the Right Honourable the Lord* Delamer; *afterwards explain'd by the Inventor* Adam Martindale, *and by his Conſent preſented to the* Royal Society *by Mr.* Collins, *and now apply'd to pertinent Queſtions in a practical Way, to make them more plain and uſeful.*

THESE *Problems* are diſtinguiſh'd into three Ranks, whoſe *Symbols* are thus to be underſtood.

p Principal,
r Rate, *viz.* 1 *l.* with its Rate, } common to all the three Ranks.
t Time,
a Amount or aggregate, proper to the firſt Rank.
ſ Sum of Principal and Arrearages, proper to the ſecond Rank.

d Difference of Principal and Worth, proper to the third Rank.

Their Capitals ſtand for the Logarithms of the Numbers ſignify'd by the ſmall ſymbolical Letters before-mention'd.

D. ſignifies *Data*, *Q. Quæſita*, *Prob. Problem*, *Reſ. Reſolution.*

The firſt Rank, concerning Compound-Intereſt for a ſingle Sum of Money.

1. Prob. *D.* p, r, t. *Q.* a? Reſ. $Rt+P=A$
2. Prob. *D.* a, r, t. *Q.* p? Reſ. $A-Rt=P$
3. Prob. *D.* p, a, t. *Q.* r? Reſ. $\frac{A-P}{t}=R$
4. Prob. *D.* p, a, r. *Q.* t? Reſ. $\frac{A-P}{R}=t$

Examples relating to the four Problems in order.

Queſt. 1. *What will* 15 l. 10 *s. amount to in* 12 *Years, at* 6 per Cent. *Compound-Intereſt?*

Anſw. 31 *l.* 3 *s.* 9 *d.* 1 *q.* as appears by the Work.

R. viz. of 1.06=0.25306
t= 12

050612
025306

Rt =0.303672
15.5 =1.190332

A. 31.188 =1.494004

Queſt. 2. *What is* 31 l. 3 s. 9 d. 1 q. *due twelve Years hence, worth in ready Money, abating after* 6 per Cent. *Compound-Intereſt ?*

Anſw. 15 *l.* 10 *s.* as here appears.

$$\begin{array}{rr} A.\ 31.182 = & 1.494004 \\ R = & 0.025306 \\ t & 12 \\ \hline & 050612 \\ & 025306 \\ \hline Rt = & 0.303672 \end{array}$$

$$A - Rt = P = 15.5 = 1.190322$$

Queſt. 3. *At what Rate of Compound-Intereſt will* 15 l. 10 s. *amount to* 31 l. 3 s. 9 d. 2 q. *in twelve Years ?*

Anſw. At 6 *per Cent.* as here.

$$\begin{array}{r} A = 1.494004 \\ P = 1.190382 \\ \hline 0.303672 \\ \hline \end{array}$$

$$12)0.303672\ (0.025306 = 1.06$$

$$0$$

Queſt. 4. *In what Time will* 15 l. 10 s. *amount to* 31 l. 3 s. 9 d. 1 q. *at* 6 per Cent. *Compound-Intereſt ?*

Anſw. In twelve Years.

$A = 1.494004$
$P = 1.190332$

$R .025306)\ 0303672\ (12 = t$

0

The ſecond Rank, touching Annuities in Arrear, grounded upon theſe two Axioms.

1. The Annuity and Rate of Intereſt being given, the Principal correſpondent to that Annuity, is in Effect given alſo, being eaſily found by the Rule of Three, thus ;

As the Intereſt of any Principal (*ex gr.* of 1, 10, 100, 1000, *&c.*) *is* to that Principal, *ſo* the Annuity of Penſion *to* its Principal.

2. The Sum of the Principal and Arrearages of all the Payments being found, the Arrearages alone may be obtain'd by ſubſtracting the Principal from that Sum.

1 Prob. *D. p, r, t. Q s ?* Reſ. $Rt+P=S$
2 Prob. *D. s, r, t. Q p ?* Reſ. $S-Rt=P$
3 Prob. *D. p, s, t. Q r ?* Reſ. $\frac{S-P}{t}=R$
4 Prob. *D. p, s, r. Q t ?* Reſ. $\frac{-P}{R}=t$

Examples ſuited to the firſt and laſt of theſe four Problems.

Queſt. 1. *What will* 33 l. per Annum *amount to in* 14 *Years, at* 6 per Cent. *Compound-Intereſt ?*

Anſw. 693 *l.* 10 *s.* as here.

```
6 . 100 :: 33
         33
     ------
        300
       300
     -------
  6) 3300 (550
     30
     --
      30
      30
      --
       00

R=0.035036
t=      14
   ---------
   0.101224
   0.25306
   ---------
   0 354084
```

$Rt=0.354284$
$P=2.740363$

$S=3.094647=124315$
5501

$693|5$

Queſt. 2. *In what Time will* 33 l. per Annum *raiſe a Stock of* 693 l. 10 s. *at* 6 per Cent. *Compound-Intereſt?*

Anſw. In 14 Years, as here is evident.

6 . 100 :: 33 . 550

$550+693.5=1243.5=s.$

$S=3.094647$
$P=2.740263$

25306) 0.354285 (14
25306

101224
101224

0

The third Rank of Problems touching Annuities anticipated or bought for a Sum in Hand (or that which is equivalent) at Compound-Intereſt diſcounted, is bottom'd upon the former of the two Axioms above-mention'd, and this that followeth:

Axiom. If the Difference of the Principal and Worth be once found, the Worth is eaſily obtained by ſubſtracting that Difference from the Principal,

cipal, which is ever greater, being the Worth of the Annuity at that Rate for ever.

1 Prob. *D. p, r, t. Q d?* Reſ. $P-Rt=D$
2 Prob. *D. d, r, t. Q p?* Reſ. $D+Rt=P$
3 Prob. *D. p, d, t. Q r?* Reſ. $\frac{P-D}{t}=R$
4 Prob. *D. p, d, r. Q t?* Reſ. $\frac{P-D}{R}=$

Examples fitted to the firſt and fourth of theſe Problems.

Queſt. 1. *What is* 17 l. 10 s. per Annum *to continue for* 11 *Years, worth in preſent Money, at* 8 per Cent. *Compound-Intereſt allow'd to the Purchaſer?*

Anſw. 124 *l.* 18 *s.* 8 *d.* as here is ſhewn.

8 . 100 :: 17.5 ?
17.5
———
500
700
100
———
8) 1750.0 (218.75
———
0

$R=0.033424$
11
———
033424
033424
———
$Rt=0.367664$

P=2.339948
Rt=0.367664
——————-218|175
D=1.97224=93|817
124|933

Note, That if inſtead of ſubducting *Rt* from *P*, I had turn'd *Rt* into the Arithmetical Complement 9632335, and added that to the *P* 2.339948, it would have done the ſame Thing in a more convenient Manner, (ſave that it is not ſo ſuited to the Letter of the Problems) as here is evident, 10 being rejected (as in this Caſe it muſt ever be) from the *Index*.

0.033424
11
033424
033424
0.367664
9.632335
2.339948
1.972283

Queſt. 2. *In what Time will* 17 l. 10 s. *pay off a Debt of* 124 l. 18 s. *allowing the Creditor after* 8 per Cent. *Compound Intereſt?*

Anſw. In 11 Years, thus manifeſt.

8 . 100

$$8 \,.\, 100 :: 17.5 \,..\, 218.75 = p$$

$$\begin{array}{r} 124.933 \\ \hline 93.817 = d \end{array}$$

$$\begin{array}{r} P = 2.339948 \\ D = 1.972284 \\ \hline \end{array}$$

$$R = 33424)\, 0.367664 \,(11$$

$$\begin{array}{c} \hline 0 \end{array}$$

Any one that underſtands the very Elements of *Algebra*, may contract theſe twelve Problems into three; for the firſt of any Rank will, by Reduction, Application, and Tranſpoſition, produce the reſt. Then the Work of the ſecond Rank may be perform'd by the firſt, if one but underſtand, that inſtead of the Penſion, he muſt take the principal Correſpondent to it, and work with it 'till he have found the Amount; from which the Principal muſt be ſubducted, when the Arrearages of an Annuity are ſought, and ſo proportionably in the reſt of the Problems.

My noble Lord *Delamer* only noted down, for his own Uſe, $Rt+P=A$, and $P-Rt=D$; by which, and a ſmall Canon of Logarithms, he will quickly anſwer any Queſtion of this Kind. But for the Help of young Mathematicians, I have ſet them forth thus explicitely.

The only Inconvenience of any Importance that I can yet diſcover in this Method, is, that in both Ranks concerning Annuities, the ſecond and third Problems are rather for Demonſtration of the other, and to compleat the Rounds, than for any other great Uſe, proceeding upon ſuch *Data* as are ſeldom given for finding the Penſions and Rate, (or if they were, the Work would be render'd uſeleſs) yet we are not left without ſufficient Help to find out Penſions or Annuities by plain and proper *Data*. For in Reference to the ſecond Rank, if the Arrearages (or Stock to be rais'd) with the Rate of Intereſt and Time, be given for finding out ſuch an Annuity, as at ſuch a Rate, and in ſo much Time, will raiſe a given Stock by its Arrearages, 'tis eaſily found thus:

Suppoſe an Annuity at Pleaſure, and by the firſt Problem of the ſecond Rank, find out its Arrearages; then ſay by the Rule of Three.

As the Arrearages found, *to* the ſuppos'd Annuity; *ſo* the Arrearages given, *to* the Annuity requir'd.

For clearing whereof, let this be the Example.

Queſt. *What Annuity will, at 6* per Cent. *Compound-Intereſt, raiſe a Stock of 693* l. 10 s. *in* 14 *Years?*

Anſw. 33 *l. per Annum,* as here is manifeſt.

Suppoſe 30 *l.* then the Work goeth on thus:

6 . 100 :: 30
30

6) 3000 (500
300

R. o.

R. 0.025306
14

0.101224
0.25306

Rt=0.354284
2.698970

S=3.053254=1130|46
500|

630|46

630.46 . 30 : : 693.5 ?
30

630.46) 20805.0 (32.999

44046

Here we account 32.999 for 33, being ſo much, within an inconſiderable Trifle.

Likewiſe in Relation to the third Rank, if the Worth, (or Price) Rate, and Time be given, and the Penſion to be purchas'd, be requir'd, find the Worth of any ſuppos'd Penſion by the firſt Problem of the third Rank, then the Proportion ſtands thus:

As the Worth found, *to* the ſuppos'd Annuity; *ſo* the Worth (or Price) given, *to* the Penſion requir'd; as in the Example following.

N Queſt.

Queſt. *What Annuity, to continue eleven Years, will be purchas'd for* 124 l. 18 s. 8 d. *at* 8 d. per Cent. *Compound-Intereſt?*

Anſw. 17 *l.* 10 *s.* as here.

Suppoſe 12 *l.* Then

8 : 100 : : 12 ?
12

200
100

---

8) 1200 (150
8

40
40

00

R=0.033424
11

0.033424
0.33424

Rt=0.367664

P=2.176091
Rt=0.367664

150†
1.808427=641332

851668
85.668

85.668 . 12 : : 124.933 ?
12

249866
124933

85.668) 1499.196 (17.5

60

If the Interval betwixt every two Payments be leſs than a Year, conſider what Part it is; whether $\frac{1}{2}$, $\frac{1}{4}$, $\frac{1}{12}$, $\frac{1}{13}$, $\frac{1}{52}$, $\frac{1}{365}$, *&c.* and by the Denominator of the Fraction ſignifying that Part, divide the Logarithm of 1 *l.* and its Rate of Intereſt, (uſually call'd *the Logarithm of the Rate)* then the abſolute Number anſwering to that Quotient, being made leſs by an Unite, will be a new Deviſor, whereby dividing the given Penſion ſo payable, half, yearly, quarterly, *&c.* the correſpondent Principal will appear in the Quotient, with which you may proceed, as if the Payments were ſo many yearly ones; as this next Example ſhews.

Queſt. 1. *What is a quarterly Rent of* 3 l. 15 s. *to continue thirteen Years and one Quarter, worth in ready Money, at* 6 per Cent. *Compound-Intereſt?*

Anſw. 137 *l.* 10 *s.* 1 *d.* as appears here.

R=4) 0.025306
0.006326=1|01467
—1|

|01467

01467) 3.75000 (235.623

1059

$\frac{1}{4}R=0.006326$
Number of Quarters 53

0.018978
0.31630

$\frac{1}{4}Rt=0.335278$

Ar. C. 9.664721
$P=2.307600$

2551623
$2.872321=110|119$

1371504

Whereas I multiply'd the fourth Part of the *Log*. of the *Rate*, viz. 0.006326 by 53, (the Number of Quarters) I might as well have multiply'd the whole *Log*. of the *Rate*, viz. 0.025306 by 13.25, *i. e.* thirteen Years and one Quarter, and it would have been full as exact, or rather more, (two Places being cut off from the *Logarithm* ſo multiply'd towards the right Hand:) I ſay, rather more exact, becauſe there remain'd 2 when I quarter'd the *Log*. of the *Rate*.

Queſt. 2. *What is* 5 s. per *Week, to continue ſeven Years and three Quarters, worth in ready Money, at* 8 per Cent. *Compound-Intereſt?*

Anſw. 75 *l.* 17 *s.* 8 *d.* 2 *q.*

52) 0.033424 (0.000642=.00148

40

.00148) .25000 (168.918

136

R=0.033424
t=7.75

0 167120
2 33968
2 33268

Rt=0.259036.00
Ar.+9.740960
P=2.227675

168|918

1.968638=93|033

75|885

Here I multiply'd (not by the Number of Weeks) but by the Number of Years and Quarters, cutting off two Cyphers from the Product. And I alſo took the Arithmetical Complement of 0.259036, *viz.* 9.740963, and added it to the Log. of the Principal, inſtead of ſubſtracting the Log. 0.259036 from it.

Laſtly, As to the Rate of Intereſt, according to the Senſe of Dr. *Newton*, Mr. *Dary*, and others,

thers, I ſee not why this Method may not be made Uſe of, as well as any other. This univerſal Rule being firſt underſtood: *In Queſtions* belonging to the *ſecond Rank*, the *greater Rate of Intereſt*, the *greater Arrearages*; and the *leſs Rate*, the *leſs Arrearages.* But in *Queſtions* belonging to the *third Rank*, the *greater the Rate of Intereſt*, the *leſs* the *preſent Worth*, (or Price) and the *leſs* the *Rate of Intereſt*, the *greater* the *Worth*, *& vice verſa.* I ſhall ſhew this in anſwering the Queſtion following, concerning a yearly Payment of 1 *l.* becauſe that, by bare Multiplication, may eaſily be apply'd to any other.

A Field worth 1 *l. per Annum* clearly, is offer'd to be let 11 Years for 15 *l.* to be pay'd at the End of thoſe Years. What is the Rate of Intereſt demanded for the ſeveral Payments?

Anſw. Firſt, I ſuppoſe *6 per Cent.* and trying it by the firſt Problem of the ſecond Rank, I find the Arrearages to be but 14 *l.* 19 *s.* 5 *d.* which is *6 d.* 3 *q.* too little.

Then trying what the Arrearages will amount to at *6.2* (or *6 l.* 4 *s.*) *per Cent.* I find 15.13, or 15 *l.* 2 *s.* 7 *d.* 1 *q.* Perceiving then I have overſhot my Mark, I make my third Tryal at 6.1 (or 6 *l.* 2 *s.*) *per Cent.* and the Reſult is 15.05, or 15 *l.* 1 *s.* which is pretty near, being but 1 *s.* above the Truth.

But that I may yet bring it nearer, I firſt ſubſtract the Reſult at *6 per Cent.* which is 14.971 from the Reſult of the Arrearages at 6.1, *viz.* 15.05, (becauſe theſe are the Reſults that come neareſt to the Truth) and their Difference is .079.

2. I ſubſtract the Rate 6 from the Rate 6.1, and there reſteth 1.

3. I ſubſtract the neareſt Reſult to 15, *viz.* 14.971, from 15 the given Arrearages, and their Difference is 029. Then working by the Rule of Three, I find (as followeth) .0367.

.079 . 1 :: 029

1

.079) .0290 (.0367

7

Which .0367 being added to 6, gives 6.0367, or *6 l. 0 s. 8 d. 3 q. per Cent.* Compound-Intereſt. And that this Rate exactly fitteth, is plain by the following Work.

6.0367 . 100 :: 1

1

6.0367) 100.0000 (16.565

20245

R. 0.025456

11

0.025456

0.25456

0.280016

1.219191

1.499207=31|565

16|565

15|1000

But perhaps it will be ſaid, that tho' in this, and all other Matters foregoing, I agree well enough with the learned Authors before-mention'd, and others that have writ of theſe Subjects; yet, in my Country-Almanack for the Year 1677, the fourth *Problem* agrees neither with them, nor what I have here written, but apparently claſheth with them.

I confeſs this Charge had been very juſt, had that *Problem* been deſign'd for the ſame End, and produc'd a *different* Effect; (for in ſuch a Caſe, to differ, is to contradict.) But foraſmuch as in my very Entrance upon it, I began thus: *There is a* Problem *in ſome learned Mens Works, ſeemingly of the ſame Importance with this, but indeed much different both in the Deſign and Effect*; and after in anſwering Objections, ſhow wherein the Deſign differs, I cannot but admire the Undertakings of that able Artiſt, who was ſo much at Leiſure, as to prove, with a great deal of Pomp, that mine will not attain the End for which I declar'd it was never deſign'd, as clearly as Words can utter it. A Sword may be a very good one, yet a very bad Inſtrument to fell Trees with. But I hear he is dead, and I ſhall rather lament the Loſs of him, and divers other famous Mathematicians, (which Death hath of late depriv'd us of) than unneceſſarily to expoſe the Impertinence of his Paper to the publick View; or ſo much as name him, to the Prejudice of his Memory. But from henceforth I expect from all ingenious Perſons, that they neither take for granted what I profeſſedly deny and diſprove, nor urge my Objections

jections againſt my ſelf, without taking Notice of my Anſwers.

For underſtanding of what follows, it were very convenient to have inſerted herein the whole Diſcourſe in the Country-Almanack about this Buſineſs; but becauſe this little Paper cannot afford it Room, I ſhall only point briefly at the Deſign and Management; and anſwering all the Objections I ever met with of any ſeeming Importance, make Things as clear as I can in ſo narrow a Compaſs. The Deſign was to diſcuſs, in plain Language, (ſuitable to Country-mens Underſtanding) this practical Queſtion wherein they are oft concern'd, *viz.* Whether it be more Advantage for the Lender to receive for 100 *l.* in Hand, Compound-Intereſt at 8 *per Cent. viz.* 71 *l.* 7 *s.* 7 *d.* 3 *q.* at the End of ſeven Years above the Stock of 100 *l.* ſuppoſing it can be legally aſſur'd, (as in *Ireland* it may, and in *England* by Equivalence in Goods or Lands, without mentioning Intereſt) or to enjoy a Farm for ſeven Years in Conſideration of 100 *l.* that will clear him juſt 20 *l. per Annum*?

My Anſwer was, That the former was the better Bargain, (and conſequently the higher Rate of Intereſt for the whole Stock during the whole Term) for which I gave in theſe Grounds under the feign'd Perſons of *A* and *B*.

1. *A* is to receive (as is ſaid) 171 *l.* 7 *s.* 7 *d.* 3 *q.* and if *B*, who takes the Farm, receive not equivalent, his Rate of Intereſt is lower.

2. *B* receives only 140 *l.* by 20 *l. per Annum*; only he hath the Advantage to improve the ſeveral Payments from the Time they grow due, to the End of the Term.

3. Theſe muſt be computed at ſome certain Rate of Compound-Intereſt; for to compute them at no Rate of Intereſts, or at Simple-Intereſt, or one taken up arbitrarily, will not ſute the Caſe.

4. The Rate tolerated by the Statute, *viz.* 6 *per Cent.* under which none will take, and above which none dare expreſly bind any to give, and at which any reſponſible Man may be fitted, is to be preferr'd before any other.

5. At this Rate the 7 Payments will amount but to 167 *l.* 17 *s.* 6 *d.*

Of theſe 5 Pillars, the 1ſt, 2d, and 5th were never attempted to be ſhaken by any that I know of: What Aſſaults have been made againſt the other two, or Deſign of the whole Fabrick, I ſhall briefly conſider; and I find them (beſides thoſe anſwer'd when I firſt publiſh'd that Problem) to be theſe three.

1 *Obj.* The Queſtion is not at all, how the Receiver improves his Payments, but what Improvements was made in the Debtor's Hands, and the ſame Rate carry'd on.

Anſw. We agreed that the Rate is not to be computed according to what the Uſurer actually makes of it. If he gives away, loſes, or lends freely all the ſeveral Payments; or if he make new Bargains more oppreſſive than the original one, the true Value of the Loan of ſo much Money for ſuch Terms, is one and the ſame. But I utterly deny that it is to be reckon'd, as if the ſame Rate muſt be carry'd on, and that for unanſwerable Reaſons (as I ſuppoſe them to be) laid down in my former Diſcourſe, or eaſily colligible from it.

1. The Laws of our Nation prohibit, upon ſevere Penalties, the taking of more than 6 *per Cent.* therefore that is the utmoſt of the legal Worth, which he that exceeds, runs (as I take it) the Hazard of all, and a great Fine.

2. If he can evade the Penalty, no reſponſible Man needs to give more than 6 *per Cent.* and few are willing to give more than they need.

3. If he get over both theſe Blocks, and make new oppreſſive Bargains, this is nothing to the Queſtion as I propounded it; for that was, whether *A* or *B* receiv'd the higheſt Intereſt for his Money, *by Virtue of the above-mention'd Bargains*, not by Virtue of occaſional after Bargains. When the Debtor hath paid in a Year's Penſion, he hath done with it; and if he have it not ready, he may take it up at ordinary Intereſt, and the Proportion is broken off for ſo much.

2 *Obj.* If we regard Laws in the Caſe, what need we any Rules concerning Compound-Intereſt, ſeeing the Laws of the Land allow only Simple-Intereſt?

Anſw. 1. The Laws are not againſt Compound-Intereſt, as it may be manag'd; that is, the Uſurer may receive his Simple-Intereſt at the Year's End, and put out that as a new Stock, and ſo undeterminately, from Time to Time; or if you will call this Simple-Intereſt, it's the ſame to the Purſe.

2. I am told they have Ways in *London* for putting out very ſmall Sums to mean Traders upon ſufficient Security; and then it is both legal and practical; tho' I ſay not how lawful before God, eſpecially as I hear ſome uſe it.

3 *Obj.* It ought to be a Queſtion only of Art, without Dependance upon Laws and Uſages, it being the Nature of Art in theſe Kind of Queſtions, not to ſhew ſo much what ought to be done, as what is really done.

Anſw. 1. It is one Queſtion what is the Nature of Art, and another how far Art is concern'd; that is, whether nothing elſe, ſave the Rules of Art, be regardable in the Caſe; which I deny, becauſe Laws and Uſages have a great Influence upon it, hindering the Continuance of the Proportion.

2. I conſider not the Laws as pinching the Uſurer's Conſcience, (as to what is lawful) but as tying up his Hands, and ſo obſtructing the proportionable Increaſe of his Gain.

3. Whatſoever may be ſaid of Art, (as Art in the ſtrict Notion of it) the Artiſt muſt not be ſuch a Slave to the Rules of it, as not to allow for unavoidable Obſtructions and Irregularities. I hope I may be allow'd to tell my Scholars that learn Navigation, that though the direct Courſe from one Port to another, be upon ſuch a Point of the Compaſs, yet other Courſes muſt be ſteer'd ſometimes in Regard of Rocks, Shallows, crooked Channels, Currents, Trade-winds, Convenience of Harbour, and freſh Supplies; or to avoid Pirates, Enemies, Forts, and Places where great Cuſtoms or Payments will be exacted, and many ſuch Things, which the experienc'd Sea-man is better acquainted with, than I with their Names. And to ſay to ſuch as learn Merchants Accompts, that though it were more artificial and rational, that Rebates of Intereſt for Money paid before it,

be due, ſhould be computed at Compound-Intereſt, (as certainly it is ;) yet foraſmuch as it is uſual with Merchants to allow no more than Simple-Intereſt, (as appears by printed Accompt-Books) they muſt ſubmit to the Laws of the great Tyrant *Cuſtom*.

An *Artiſt* hath not the ſame Liberty of Suppoſition in anſwering Queſtions, (eſpecially ſuch as are real and practical) that he hath in propoſing Queſtions, or receiving them from others, when Tryal of Skill is only or chiefly intended. I may, without Abſurdity, in this latter Caſe, demand or find the Amount or preſent Worth of any ſingle Sum of Money, or Yearly Penſion for any Terms, propounded at any Rate of Intereſt given, though ſuch as is never likely to come in Practice, *(ex gr.* at 2, 3, 14, or 20 *per Cent.)* But if I be put, by the Nature of my Work, to compute the Amount or preſent Wroth of Payments, no Rate of Intereſt being nam'd, I ought prudently to weigh all Circumſtances, and pitch upon that which is poſſible and rational. And this is not a Work of *Art*, but of *diſcreet Judgment*, (wherein great Reſpect is to be had to penal Laws, Uſages, and other Obſtructions) after which Art takes its own *Provine*, in computing after ſuch a Rate reſolv'd upon.

To make all this plainer (if poſſible) than I made it at the firſt Publication, let us, for once, ſuppoſe a rare Caſe, *viz.* That *B*, a *Mathematician*, turns Uſurer, and for 100 *l.* ready Money, takes a Farm for ſeven Years, that he lets to another for 20 *l. per Annum* clearly, knowing before-hand he could ſo let it ; and *A*, his familiar Friend, thus accoſts him; *I wonder to hear you are grown ſuch an Extortioner, as to receive* 20 l. per Annum, *ſeven Years together for* 100l. *B* anſwers, Before you find Fault with the Mote in my Eye, take the Beam out of your own: You have bought the *Reverſion* of a Piece of Land after ſeven Years for 100 *l.* for which I will *bona fide* give you 172 *l.* at the Time of your Entrance upon it; which I find by the Rules of my Art to be 12 *s.* 4 *d.* 1 *q.* above Compound-Intereſt at 8 *per Cent.*

A replies, *Learned Men ſay ſuch a Bargain as yours will clear* 9 l. 3 s. 4 d. per Cent. *and better.* *B* rejoins, 'Tis true, they do ſo; but then they ſuppoſe the ſame Rate to be continu'd; (for none will ſay, that if the Payments lie by unimproved, or be let out at an under Rate, that in ſuch Caſes that Rate of Intereſt can be anſwer'd) and this Suppoſition is really impracticable, or (to ſay the leaſt) that which a rational Man cannot depend upon. I did accidentally meet with this Bargain from the Hands of a weak Man, which yet I durſt not have accepted, (the Laws are ſo ſtrict) if it had been a Rent Charge in Money. And will you undertake to find me Fools that ſhall at every Year's End take off the ſeveral Payments, yea, and all the Increaſe of them as they grow due, upon the ſame Terms that I put out the 100 *l.* upon, and to let me Land for it? If you think you can, I will make you a great Bargain, (becauſe I know you to be a punctual reſponſible Man) you ſhall receive the firſt Yearly Payment, and at the End of the ſecond Year, pay me Simple-Intereſt for it at 6 *per Cent.* as the Statute allows,

lows, and I will inſtantly return it to you, together with the ſecond 20 *l.* which we will join into one Sum, and you ſhall take it at the ſame Rate; and thus we will do every Year to the End of the Term, ſtill adding that Year's Growth to what was before, and ſo keep up all the Accounts to 6 *per Cent.* and if you can make any more profitable Uſe of it, much Good may it do you, and I will heartily thank you to boot, for helping me ſo readily to place out my ſmall Parcels without Loſs. But if you dare not do this, let Ingenuity mollify your Charge, and I ſhall not quarrel with you about your Rate of 9 *l.* 3 *s.* 4 *d.* which perhaps you borrow'd (or ſome one for you) from Dr. *Newton* his *Trigonometria Britannica*, *pag.* 37. for I acknowledge it is that, and ſomewhat more, though not much; but I ſay, (which I deſire you to obſerve) that I receive no Compound-Intereſt after that Rate, but only Simple; and that not for the whole Sum during the whole Term, (as you do Compound-Intereſt for all your Stock) but only for the whole 100 *l.* for the firſt Year; for you know, that if at the End of that Year 20 *l.* be ſubſtracted from 109 *l.* 3 *s.* 4 *d.* all the Intereſt is paid, and ſo much of the Stock as brings it down to 89 *l.* 3 *s.* 4 *d.* This 89 *l.* 3 *s.* 4 *d.* being computed at the ſame Rate of Intereſt, 20 *l.* abated from it, clears the Intereſt again, and brings down the Stock much lower; and ſo Year by Year the Stock is dwindl'd away, 'till at laſt the ſeventh Payment (if the Rate were abſolutely exact, as it is near) clears off all Stock and Intereſt. And this is all I receive, ſave only the Benefit of the ſeveral Yearly Payments,

which

which I offer you (or any other ſolvent Man) at 6 *per Cent.* as aforeſaid: At which Rate (abating not a Farthing for Loſs of Time, but ſuppoſing good Places ready for every Parcel as it becomes due) it will but amount to 167 *l.* 17 *s.* 6 *d.* which being the whole Aggregate of Stock and Intereſt, if we ſubſtract from its *Logarithm* the *Log.* of 100, and divide their Difference by 7, as we are directed by Mr. *Wingate*'s Λογαριθμοτεχνία, *Chap.* 5. *Prob.* 13. the Rate of Intereſt will appear to be 7 *l.* 13 *s.* 7 *d.* 2 *q.*

I profeſs freely, Sir, I cannot withſtand *B*'s Arguments; but if any other can, I ſhall neither envy his Happineſs, nor deſpiſe (if fairly and ingeniouſly offer'd) his *Animadverſions*: In that Caſe you ſhall command a Sheet from me at any Time, in Conſideration of any Thing ſo objected; but for ſuch injurious and paſſionate Diſcourſes as are apter to provoke, than convince, I confeſs 'tis ſuch a Piece of Drudgery to anſwer them, that (if I could not eaſe my ſelf by Contempt) I ſhould think it hard Meaſure that my Silence ſhould be interpreted as their Victory.

Sir, you will pardon this *prolix Appendix*, when 'tis conſider'd, that it is not intended for ſuch as your ſelf, but for ſuch to whom nothing can be too plain, by,

SIR,

Your Friend and Servant,

Adam Martindale.

A compendious Method for working out many Concluſions in Arithmetick, *wherein the* Rule of Three *is often repeated; long ſince invented, practis'd, and taught by the* Author, *but never 'till now publiſh'd.*

IN all Books of *Arithmetick* that I have had the Happineſs to peruſe, the Works of both *Rules* of Fellowſhip and Alligation alternate, are perform'd by the *Rule of Three*, ſo oft to be repeated as there are particular proportionable Parts to be found; which proving intollerable tedious when the Partners in Fellowſhip, or the Parcels in Alligation are many, cauſed me to think of this following Courſe, every Way as plain and uſeful, and much more compendious; which, to be ſhort, is this:

The Rule.

Divide that which is uſually made the ſecond Number in the *Rule of Three*, by that which is as uſually made the firſt and the common Diviſor; that *Quotient* multiply'd ſeverally by the reſpective third Numbers, gives the particular Reſults. But here it will be neceſſary, if you uſe *decimal Diviſion*, (which I judge moſt convenient) that you continue your *Diviſion* 'till either nothing remain, or you have ſix Places of *Decimals* in the *Quotient*, accounting *Cyphers* (if there be any) into the Number. And if, upon the *Addition* of your Parcels, the Total amount not juſt to the Sum expected, but an Unit ſhort in the Integers, and three more Figures of 9 immediately following, take it for exact, for ſo it is within a Matter of nothing.

All this will be plain by three *Examples*, whereof the firſt ſhall be wrought (for Plainneſs) both in the old and in this newer Way; the other two (for Brevity) this latter Way only.

The firſt Example in Fellowſhip without Time.

A	Put into the common Stock	15	The Sum whereof is 72 *l.* and their Gain 63 *l.* what is each Man's Part?
B		24	
C		33	
		72	

The Reſolution in the old Method, is thus:

```
A 72 . 63 : : 15
        15
       ----
       315
        63
       ----
   72) 945 (13.125
       ----          Or 13 l. 2 s. 6 d.

B 72 . 63 : : 24
        24
       ----
       252
       126
       -----
   72) 1512 (21 l.
       -----
```

C 72 . 63 :: 33
33

189
189

72) 2079 (28.875
0
Or 28 *l.* 17 *s.* 6 *d.*

13.125 13-02-06
21. 21-00-00
28.875 Or thus, 28-17-06

63.000 60-00-00

In the new Way, the Work is thus done.

72) 63.0 (.875 *A*.875
15
0

4375
875

13.125

B .875 *C* .875
24 33

3500 2625
1750 2625

21.000 8.875

I hope by this Time my intelligent *Reader* is aware, that if the Partners had been many, (as in Voyages and Adventures it oft falls out) the Difference betwixt the two Methods would have been yet more ſignally conſpicuous; for one ſingle Diviſion ſufficeth, be the Partners never ſo many; though I confeſs there is yet a nearer Way by the Help of *Logarithms*; of which I ſhall preſent this Specimen.

63=1.79934055	.875=1.94201805
72=1.85732250	15=1.17609126
.875=1.94201805	13.125=1.11810931
.875=1.94201805	.875=1.94201805
24=1.38021124	33=1.51851394
21=1.32222929	28.875=1.46053199

The ſecond Example in Fellowſhip with Time.

A	laid in	43	for	8	Months.	They gain'd
B		52		5		73 *l.* *Q.* each
C		63		7		Man's Part?

The Reſolution by this new Method, is thus.

			344
A 43	*B* 52	*C* 63	260
8	5	7	441
344	260	441	1045

1045) 73.00 (.069856

480

A.069856
344

2794[illegible]
279424
209568

l. *s.* *d.* *q.*
24.03464 Or 24--0--7--2

B .069856
260

4191360
139712

18.162560
l. *s.* *d.*
Or 18--3--3

C.069856
441

069856
279424
279424

30.806496
l. *s.* *d.* *q.*
Or 30--16--1--2

Proof.

24.030464
18.162560
30.806496

72.999520

Or thus:

l.	*s.*	*d.*	*q.*
24	00	7	2
18	03	3	0
30	16	1	2
73	00	0	0

The third Example in Alligation alternate.

Suppoſe a Mixture of Wine of 119 Quarts be requir'd, that muſt be made up of theſe ſeveral Prices, 7 *d.* 8 *d.* 14 *d.* and 15 *d.* ſo as the whole may be afforded at 12 *d. per* Quart, the Parts may be found out in their Method (without Decimals) thus.

8 } 2
14 } 4
7 } 3
15 } 5
7 ——
14

Having link'd 8 to 14, and 7 to 15, and counterchang'd their Differences from the common Price 12 *d.* I find the Sum of their Differences to be 14, by which dividing 119, the Quotient is $8\frac{1}{4}$, or $8\frac{1}{2}$, which, for Convenience of Multiplication, we ſhall change into the improper Fraction, ſo the Reſolution will be thus:

Quarts.

$$\frac{17}{2} \times 2 = \frac{34}{2} = 17$$
$$\frac{17}{2} \times 4 = \frac{68}{2} = 34$$
$$\frac{17}{2} \times 3 = \frac{51}{2} = 25\frac{1}{2}$$
$$\frac{17}{2} \times 5 = \frac{85}{2} = 42\frac{1}{2}$$

119

Having our juſt Meaſure of Wine, let us try the Prizes how they ſuit our Purpoſe by Alligation medial; for conſiderable Errors may be caus'd by Miſapplication of Prices, when the Parts were truly taken; but here-under it is apparent, that each Parcel multiply'd by its Price, the Sum of the Products is 1428 Pence, which, divided by 119, give 12 for the common Price.

17	34	$25\frac{1}{2}$	$42\frac{1}{2}$
8	14	7	15
136	136	$178\frac{1}{2}$	$217\frac{1}{2}$
	34		42
	476		$637\frac{1}{2}$

$$\begin{array}{r}136\\476\\178\frac{1}{2}\\637\frac{1}{2}\\\hline 1428\end{array}\qquad\qquad \begin{array}{r}119)\ 428\ (12\\119\\\hline 238\\238\\\hline 0\end{array}$$

This Proof by Alligation medial I do not account a needleſs Curioſity, but very uſeful to be throughly underſtood; for Experience informs me, that young Men being defective in Skill, Care, and Memory, are apt to miſtake in ſeveral Points, but eſpecially one; that is, to eſteem the ſeveral Parcels to be of ſeveral Prices, from which the Differences (by which they are found) were originally taken, and not (as the Truth is) of the Prices to whom in the Counterchange they were annex'd.

As to that which ſeems to look like an unneceſſary Affection of Novelty, in linking the Prices and Differences by ſeparate Couples, I deſign'd at no higher Thing than to free the Printer (if this paſs his Hand) from the Trouble of looking up his duſty Cuts of Semilunes, interſecting or encloſing one another, as in our uſual Books of *Arithmetick*; though the Truth is, in ſuch Caſes as this before us, no linking at all is needful; but when the common Quotient is multiply'd ſeverally by all the Differences, any Price above the common may be aſſign'd to any Product made by the Difference originally belonging to an under Price, and contrarily, ſo as true Couples be obſerv'd.

ſerv'd. So here I might have aſſign'd the Price 15 to the Parcel 34, found out by the Difference 4 originally belonging to 8, and the Price 14 to the Parcel $42\frac{1}{2}$, found by multiplying the common Quotient by 5, the Difference of 7 from the common Price. But then I muſt be ſure to do Juſtice, ſo as to aſſign the Price 8 to the Parcel $25\frac{1}{2}$, found by 3, the Difference of 15 from the common Price; and the Price 7 to the Parcel 17, ariſing from 2, the Difference of 14, as here is plain.

$17 \times 7 = 119$

$25\frac{1}{2} \times 8 = 204$

$34 \times 15 = 510$

$42\frac{1}{2} \times 14 = 595$

1428

119) 1428 (12

119

238

238

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F I N I S.

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